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#2 IN THE SERIES OF *Questions and Answers About Granite Grit*

DR. G. F. HEUSER, Director
Stonemo Poultry Research Farm

Question: What are the main benefits of grit feeding that can easily and accurately be measured?

Dr. Heuser: The two main benefits are increased production (either weight or number of eggs) and feed efficiency. Increase in weight is especially important in broiler production.

Question: Are there any other important values of feeding grit?

Dr. Heuser: Yes, an insurance value. As already indicated, the gains usually are not large, but might be considerable under some situations or under stress. The feeding of grit might be of advantage to meet adverse conditions and act as insurance to counteract some of the factors which might be deficient and hence detrimental. The possible loss would be small (the cost of feeding the grit) but the gain might be considerable. In other words, there is little to lose, but there might be much to gain.

A leading poultry nutritionist has recently stated: "A couple of years ago we wondered about the need for grit in the case of broilers being fed all-mash or pelleted diets. However, we now believe that it is wise to feed grit to broilers and other classes of poultry even though they are on all-mash feeds. We have encountered several field cases where birds have become impacted with shavings and other litters, when no grit was fed. I believe that in some cases it might be possible to do a satisfactory job without grit in broilers and layers fed all-mash diets, but it seems to me since there is always a danger of the birds consuming litter, it is good insurance to have grit available."

Do you have a question regarding the feeding of granite grit? If you do, please address it to Dr. G. F. Heuser, c/o Stonemo Poultry Research Farm, Lithonia, Georgia.

STONE MOUNTAIN GRIT COMPANY, INC., Lithonia, Georgia

STONEMO GRANITE GRIT—*The Grit with the* **"EXTRA GRINDING SURFACES"**

WORLD'S POULTRY SCIENCE JOURNAL

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THE POULTRY PARASITE AND DISEASE PROBLEMS OF EGYPT[1]

W. MALCOLM REID[2]

Poultry Department, The University of Georgia
Athens, Georgia, USA

During the years 1951-55, a study of poultry parasite problems, together with observations of certain disease problems, was carried out in Egypt. Some local poultrymen felt that helminth parasites constituted a particularly serious problem in rearing the popular imported breeds of poultry. A survey and experimental work comparing susceptibility of native breeds with imported strains showed no difference in susceptibility to *Ascaridia galli*. No other helminth parasites appeared to be more severe in imported strains than in the smaller native birds (Reid 1953, 1955, 1956). It was concluded that although helminth parasites sometimes caused losses in poultry, they did not present problems peculiar to Egypt.

The major parasite problem is the soft tick, *Argas persicus*, which is present in large numbers in most poultry establishments. Due to climatic differences, it is a more serious problem in southern Egyptian villages than in those in the Delta (Reid, 1956). In the south, every villager knows the tick, while in northern Egypt, although the tick may be found, villagers are not always familiar with it. In poorer homes where chickens are raised as house pets, there was less of a problem than where wooden coops offered ideal hiding places. On the various types of government poultry farms, masonry construction was used in an effort to eliminate ticks. Ticks soon became established on these farms and only by continual treatment with some of the newer insecticides such as benzene hexachloride, could they be eradicated. The ability of the tick to survive long periods of starvation while in hiding permits some to escape the effects of insecticides in spite of long residual properties. Heron rookeries near some of these government farms served as a continual source of reinfection. The tick was responsible for severe outbreaks of spirochaetosis.

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1. Paper presented August 7, 1958 at the 50th anniversary meeting of the Poultry Science Association, Ithaca, New York. Journal Series No. 93, College Experiment Station, University of Georgia, Athens, Georgia.
2. Fulbright Research Scholar at the Veterinary College, Cairo University, 1951-52. Head of the Poultry Unit, U. S. Operations Mission to Egypt, 1952-55.

This disease has been shown to be more serious with imported breeds than with native birds (Dardiri, 1945). Treatment was possible by means of arsenical drugs, but the uncertainty of exposure time makes a treatment program impractical in large scale enterprises. Tick and spirochaetosis control then constitute major unsolved disease problems.

Nutritional diseases are still common due to unbalanced rations. The "Point Four" (United States technical assistance program) had some part in the birth of the mixed feed industry which is now of growing importance. "Point Four Chicken Feed" is now being manufactured by several different firms and the advantages of proper feed formulation are becoming more generally recognized.

Losses due to bacterial diseases are common. Although pullorum is controlled on some of the larger farms, a village control program working with the famous native hatchery of Egypt and with other village hatchery programs was getting underway in 1955. Imported stock from the New England area was highly susceptible.

Virus diseases constitute the major cause of mortality. If the average farmer is asked about his mortality rate, he will probably give a conservative estimate of 20 percent, but may admit that it sometimes goes to 50 percent or higher. Under village conditions, the entire poultry population is sometimes wiped out in a week. Presumably most of these outbreaks are Fowl Pest or Newcastle disease. Locally manufactured vaccines are available against these diseases although strains useful on baby chicks are still in experimental stages.

In the course of the Point Four program, large importations of baby chicks were brought in from U.S.A. Properly supervised under preventative disease control programs, these birds did well and farmers were pleased with increased income due to higher productivity and larger eggs from imported strains. An outbreak of a CRD-like epizootic occurred on the government farms some three months after the last importation. Governmental routine prevented establishment of the origin of this disease outbreak. It has been assumed by some workers that a new disease was introduced with U.S. chicks. The outbreak was confined to the larger government farms and did not affect the village programs. Since there was no major increase in the disease problems of the country

following this outbreak, observers concluded that the native birds were relatively resistant to the condition. It may be added that turkey sinusitus which is now considered to have the same etiological agent as CRD was first reported in Egypt during the last century. Such assumptions instigated certain propaganda, which obscured the more lasting programs, in which improved strains of poultry were introduced into concentrated village areas, and followed up with intensive vaccination, animal health, extension and marketing programs. This type of activity was best directed under the Animal Health Center which was pioneered through the National Research Council under the direction of Col. Omar Draz of the Egyptian Army Veterinary Corps. The organization of this type of center is described by Draz and Zahr (1953) and by Dardiri and Reid (1953). Where this type of center was properly activated, poultry production was greatly increased with resulting economic improvement in the villages. Several land-reform, governmental and private agencies are continuing such chick distribution programs with extension follow-up at the present time.

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FEEDING GRADED LEVELS OF DATES AND DATE PITS TO CHICKS

HAKKI S. TAMIMIE
College of Agriculture, Abu-Ghraib, IRAQ

INTRODUCTION

Previously the results of feeding high levels of dates and date pits fed singly and in combination (Tamimie, 1958) showed a depressing effect on growth was induced by the beginning of the second week of the trial. This depressing effect was accompanied by a high percentage of mortality in all groups fed dates and date pits, alone or in combination.

These results led us to continue our investigation into the use of dates and date pits in our economical rations and to supplement part of the ration ingredients with either dates or date pits. If dates or date pits could be included in rations for poultry, the date industry in Iraq as well as the local poultry industry and local poultry rations would be improved.

EXPERIMENTAL PROCEDURE

Two hundred White Leghorn chicks of both sexes were reared in electric battery brooders. At the end of the first week one hundred and eighty chicks were chosen after weighing all the chicks at that time and dividing them into different weight groups. Three groups of medium size weight were taken and distributed into nine lots. In each lot twenty chicks were distributed in a randomized block.

The chicks were fed "ad libitum" one type of ration, "starter ration", for the first week. Then the groups were distributed as follows:

1. Control (Starter ration)
2. Control + 2% Dates
3. Control + 4% "
4. Control + 8% "
5. Control + 16% "
6. Control + 2% Date pits
7. Control + 4% " "
8. Control + 8% " "
9. Control + 16% " "

Before incorporating the dates and date pits with the experimental ration, the following steps were conducted in order to assure the uniformity of their mixing with the diets, the ration palatability and to lower the ration's dampness:

1. Amounts of dates and date pits to be added to each lot were totaled and mixed, then dried separately in a "Ro-

tating Heater" for eight hours at a temperature of 85° F.

2. These separate dried amounts of dates and date pits were placed in a regular oven for ten additional hours and at a temperature of 65° F. This step was conducted in order to insure the dryness of dates and date pits before their incorporation in the ration.

3. The date pits were ground in order to insure a uniform particle size in relation to the other ingredients of the ration.

4. Both dates and date pits were mixed by hand with a small amount of ration for each particular group, then placed in the feed mixer, and mixed for ten minutes in that mixer, for all lots receiving the dates and date pits.

TABLE 1: Starter & Control Ration (18% Protein)

Ingredient	*Percentage*
Ground yellow corn	15
Ground barley	10
Cracked wheat	10
Wheat bran	15
Rice polishing	10
Ground broadbean	10
Millet	10
Linseed oil meal	5
Sesame oil meal	5
Bone meal	5
Limestone	4.5
Salt	0.5
TOTAL	100

1. Levels of dates and date pits were added at the expense of the starter rations for each group receiving dates and date pits.

2. Vitamins (A, D, B_2 and B_{12} were added. The Vitamin A & D mixture was added at a level of 1 gm. of this mixture per kilo of the diet. This mixture contained 600 units of Vitamin D and 10,000 I.U. Vitamin A per gram. Vitamin B_2 was added at a level of 16 mg. per kilo of the diet. Vitamin B_{12} was added at a level of .02 mg. per kilo of the diet.

3. Pfizer Terramycin was added to all groups at a level of 175 gm. of this mixture per hundred kilos of the diet.

EXPERIMENTAL RESULTS

The results of this experiment are divided into two groups:

A: *Results of feeding graded levels of dates (pits removed)*

In looking into Table 2 it can be found that the growth rate of chicks fed the 2 and 4% levels of dried dates was

slightly lower than that of the controls and those receiving 8% dried dates. This difference in weight at 4 weeks of age was not statistically significant. On the contrary the level of 16% dates was inferior to all levels of the date feeding.

TABLE 2: Average Weekly Weight in Grams and Mortality Rate For Feeding Dates to Chicks
(Twenty chicks per lot. No replications)

	Ration	1st wk. Weight	2nd wk. Weight	3rd wk Weight	4th wk. Weight	Total No. of Deaths
I.	Control	59	92	148	190	1
II.	Control + 2% dried dates	59	89	144	177	1
III.	Control + 4% " "	59	95	152	185	1
IV.	Control + 8% " "	60	95	170	200	0
V.	Control + 16% " "	60	87	131	142	2

B: *Results of feeding graded levels of date pits*

Table 3 shows that feeding date pits results in better growth than feeding dried dates (without the seed). The gain in weight for the groups fed date pits over the control group was observed starting from the first week of the trial or the second week in age, especially with the group receiving the level of 2% date pits. The advantageous finding for the feeding of date pits was quite clear at the termination of the experiment. No depressing effect was observed in the group receiving 16% date pits. This is in contrast to the findings observed with the feeding of high level of dates (25% or 16%), in which a depressing effect was observed in the group receiving the high level of dates. No significant difference was obtained between the control and 4, 8 or 16% date pits. However 2% date pits improve the growth rate over the control to a significant level.

TABLE 3: Average Weekly Weight in Grams and Mortality Rate for Feeding Date Pits to Chicks
(Twenty chicks per lot. No replications.)

	Ration	1st wk. Weight	2nd wk. Weight	3rd wk. Weight	4th wk. Weight	Total No. of Deaths
I.	Control	59	92	148	190	1
II.	Control + 2% date pits	60	107	170	227	0
III.	Control + 4% " "	60	92	158	198	1
IV.	Control + 8% " "	60	92	156	195	1
V.	Control + 16% " "	60	89	153	194	1

DISCUSSION OF RESULTS

A. The depressing effect of feeding 16% dates may be due to one of the following reasons:

1. Presence of a depressing factor which might depress the growth of chicks when these chicks were fed 16% dates and 25% dates as previously obtained. (Tamimie, 1958).

2. High percentage of dates mixed with the ration cause it to be damp even when various ways of drying this material have been attempted. This dampness decreases the palatability of the ration to the chicks.

3. High percentage of date sugar might not be tolerated by the chicks, which in turn caused this high mortality and poor growth.

B. The good growth obtained by feeding 2% date pits was not observed when higher levels of date pits were fed. In fact 25% date pits was detrimental (Tamimie, 1958). Good growth obtained with 2% date pits might be due to:

1. Improved palatability of the ration to the chicks.

2. The presence of an unknown growth factor or minerals present in date pits.

SUMMARY

1. Previous experiments have shown that feeding high levels of dates and date pits (25%) fed singly or in combination were not tolerated by chicks.

2. Feeding of 8% dates resulted in slightly better growth than the control. The 2% and 4% level of dried dates did not affect growth. However 16% dried dates was not tolerated by the chicks. (Table 2).

3. Feeding of 2% date pits improved the growth rate of chicks to four weeks of age. No significant improvement was obtained when the chicks were fed the levels of 4, 8, and 16% date pits. (Table 3).

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USE OF IONIZING RADIATION FOR POULTRY PRESERVATION*

D. H. SHRIMPTON

Low Temperature Research Station, Downing Street Cambridge, England

Following the development of powerful electron generators, the increasing availability of isotopes and the publication[1,2,3] in 1947 and 1948 of claims for the potential uses of ionizing radiations in the food industry, the hope arose that foods might be completely sterilized without any loss of their fresh qualities. Unfortunately from the papers read at Harwell in 1958 it was clear that not only had this hope not yet been realized but also that no technological development at present under consideration gave any promise of early success. The present position is that it is possible to sterilize by using large enough doses of irradiation but only at the expense of injuring the product. More attention is therefore being paid to the effect of lower doses. The object here is to reduce the initial bacterial contamination to a level low enough to give a worthwhile extension of storage life at refrigerated temperatures without impairing the other properties of the food.

The conference was convened by the Food and Agriculture Organization of the United Nations and was held, by courtesy of the Government of the United Kingdom, at the United Kingdom Atomic Energy Authority's Atomic Energy Research Establishment at Harwell from 17-21st November, 1958. The conference was attended by 179 representatives, from 17 European member Governments, and by 22 observers from 4 non-European member Governments and from 14 international organizations, including the World's Poultry Science Association. A draft report[4] of the conference was adopted by the representatives and a full account of the proceedings is to be published.[5]

Ionizing radiations are of 2 classes: electromagnetic waves, which include X-rays and gamma rays, and particulate radiations, which include cathode rays and beta rays both consisting of fast electrons, and particles of greater mass, e.g. protons, deuterons and alpha rays. These particles of greater mass are unsuitable for use with food not only be-

* A report to the World's Poultry Science Association on a European meeting on the use of ionizing radiation for food preservation held at Harwell, England, on November 17-21, 1958.

TABLE I

Potential commerical sources of ionizing radiations

1. *High speed electrons* *Generator*	*Source of electrons*	*Method of acceleration of electrons*	*Characteristic of generator*
Linear accelerator	Cathode Tube	Electromagnetic radiation, resulting in the passage of a radio wave along a tube of width comparable with the wavelength (i.e. a wave guide)	Very high accelerating voltages are not used so that insulation is not a problem.
Van der Graaf	Electrostatic device (a development of the Wimshurst machine)	Electrostatic accelerating tube in which consecutive anodes are arranged at increasing potentials relative to the cathode.	Simplicity of electrostatic device for producing electrons. Useful up to 3 MeV.
Cascade generator	High voltage current discharged from banks of condensers	Electrostatic accelerating tube	No moving parts, but insulation difficulties at high energies
Resonant transformer	High voltage current from self rectifying transformer	Electrostatic accelerating tube	No moving parts but insulation difficulties at high energies.

2. *Gamma rays* *Source*	*Method of production of source*	*Rate of decay of source*
Co^{60} (radioactive cobalt)	Irradiation of cobalt in an atomic reactor	12½% per year
Cs^{137} (radioactive caesium)	Chemical separation from spent atomic fuel elements after they have been left to decay for about 100 days.	2½% per year
Spent fuel elements	"Rods" from nuclear reactors e.g. those installed in nuclear power stations.	Useful period 2-100 days. Characterized by very high energy of great penetrating power.

cause they bring about nuclear transformations but also because of their very limited powers of penetration. The methods of production of X- and gamma rays and of high speed electrons are given in the Appendix, Table 1, and a brief classification of the terminology is given in Table 2.

TABLE 2

Definitions of units

Unit	*Abbreviation*	
Curie	c.	The unit of radioactivity and represents 3.7 x 10^{10} disintegrations per second. This is equivalent to 1 g. of radium.
Rad	—	Dosage corresponding to the absorption of 100 ergs per gram of irradiated material.
Roëntgen	r.	That quantity of X or gamma radiation such that the associated corpuscular emission per 0.001293 g. of air produces in air, ions carrying one electrostatic unit of quantity of electricity of either sign. — For air this is equivalent to an absorption of 83 ergs per g.
Roëntgen-equivalent-physical	rep or r.e.p.	A unit which has not been formally defined, but which some workers have equated numerically with the roentgen. Its value may vary between 83 and 93 ergs per g. of absorbing energy depending upon the energy of the radiation, and upon the nature of the absorbing material.

NOTE: Production capacity of an electron accelerator can be calculated from:—Output capacity (watts) = Beam energy (MeV^1) x Beam current, (m^2A) x Pulse duration ($micro^{-3}$ secs) x Pulse repetition frequency/1000; e.g. 1 kilowatt of electron beam output will irradiate 700 lbs. with a dosage of 1 Megarad[4] if absorption efficiency is 90%.
1. volts x 10^6. 2. amperes x 10^{-3}. 3. seconds x 10^{-6}. 4. rads x 10^6.

From the point of view of food preservation, X-rays, gamma rays, cathode rays and beta rays are essentially similar, but the most suitable are gamma rays and cathode rays and the experimental work reported at Harwell concerned these two types. The use of these two irradiations is complementary rather than competitive, gamma rays tending to be more suitable when a deep penetration is required whilst cathode rays are advantageous for the irradiation of films and for treatments requiring a shallow but defined depth of penetration. From the discussions of the papers of Jefferson and of Murray on gamma irradiation and of Perry and Crowley-Milling on cathode ray irradiation it was estimated that the costs of applying either process are likely to be com-

parable and not so high as to be impractical if an attractive process was developed. It was stated that sufficiently large sources of either type could be made available during the next few years.

Although the application of doses large enough for complete sterilization (3-6 megarads) at present causes unacceptable changes in foods in respect of colour, flavour, odour, texture and loss of essential nutrients (Appendix, Table 3),

TABLE 3

(from Kraybill)

Effects of irradiation on the nutritive value of foods.

Nutrient	*Dose Megarads*	*% destruction in:— Beef*	*Ham*	*Milk (fresh or dried)*
Niacin	3	2	2	35
	6	1	2	20
Riboflavin	3	5	0	0
	6	4	0	0
Thiamine	3	76	87	0
	6	85	96	0
Vit.B_{12}	0.046	—	—	30
Vit.A	0.48	—	—	85
Vit.E	very readily destroyed			
Vit.K	3[1]	diet fed to chicks caused an incidence of hemorrhage to the extent of 86-95%.		
Biological value of protein.			Reduced[2] from 89.52 to 81.76	

[1] A diet irradiated with 6 megarads and fed to rats prevented coprophagy.

[2] May be due to loss in cystine or lysine.

smaller doses (<1 megarad) have potentially many useful applications. Treatments of foods with these smaller doses have been termed "pasteurization processes". This term is, however, an unfortunate one since it is in no way comparable with the established process of pasteurizing milk by heat where a specific pathogen, the tubercle bacillus, is eliminated. Indeed, the need was stressed by Ingram and Thornley for the continuous refrigeration (at <5°C) of foods treated with low doses of radiation in order to prevent the subsequent multiplication of any bacterial pathogens not destroyed by irradiation; this view was confirmed by the general opinion of the conference.

There is some change in all foods after irradiation, but

it was a general experience that these changes are least in pork and poultry meat and in some egg products. The potential uses of ionizing radiations for these commodities is therefore of special interest to poultry science workers.

From a bacteriological point of view, Thornley† reported that there was less microbiological change in minced chicken meat held anaerobically for 3 weeks in cans at 5°C after irradiation with 0.25 megarads* than in unirradiated meat held under the same conditions for only 3-5 days. With whole eviscerated chicken irradiated with 0.8 megarads and held at 1°C the suppression of microbial multiplication was even more striking; treated carcases kept for 55-60 days, compared with 10-12 days for the controls, before any change in odour was detected. In this particular instance the final spoilage flora consisted almost wholly of bacteria of the *Achromobacter* group. Because these organisms are sensitive to the tetracycline antibiotics a combination of antibiotic treatment with irradiation gave even greater extensions of the period spent at 1°C before any change in odour developed.

It was demonstrated by Coleby, however, that to assess the storage life of irradiated whole eviscerated poultry by odour assessment and microbiological examination only was likely to give a very false impression of the effectiveness of the irradiation treatment. He reported that although chickens irradiated with 0.8 megarads were preserved from spoilage by bacteria for about 8 weeks at 1°C, the useful storage life before loss of eating quality became apparent was somewhat less than 3 weeks, i.e. about a 50% gain on the storage life of chickens which had not been irradiated. Moreover, this deterioration was detected, not only by a trained taste panel, but also by a group of domestic consumers.

A summary of the results of these experiments with eviscerated poultry are shown in the Appendix, Table 4 and detailed accounts of these experiments have been published[6] or will be published[7–9].

The treatment of eggs and egg products was described by Brooks, Hannan and Hobbs. Eggs in shell are not particularly susceptible to bacterial attack and irradiation does not seem to be a promising method of improving their keeping qualities particularly as it has already been reported[10] that

† See Appendix
* 1 Megarad = 1 million rads

TABLE 4

(from Coleby and from Thornley)
Effects of irradiation with gamma rays from Co^{60} on whole eviscerated chickens held at 1°C

Treatment	*Storage life (days)*	
	a) before onset of microbial spoilage	*b) before losses of quality become apparent*
Control	10-12	—
0.25 megarads	23-27	—
0.50 magarads	34	—
0.80 megarads	60	<21

irradiation of the white imparts an off-flavour to it. With egg products, however, which are usually kept and distributed in either the frozen or dried state, a special bacteriological problem exists. A by no means negligible proportion of these products is contaminated with bacterial pathogens, chiefly of the *Salmonella* group. Attempts to control this contamination by increased care during manufacture have proved ineffective; there is, in fact, no relation between the magnitude of direct microscopic counts made on egg products and the presence or absence of these pathogens. There is, therefore, a need for an effective process to destroy salmonellae, and heat pasteurization of liquid whole egg before freezing or drying, or of the frozen product after thawing, has met with considerable success[11-15]. An irradiation process has also shown promise for both liquid and frozen whole egg[16]. The authors reported that treatment of large tins of frozen whole egg with gamma radiation at dose levels of 0.3 to 0.5 megarads were sufficient to destroy the numbers of salmonellae normally encountered in the product without impairing the baking qualities of the material. Details of some of the results of their experiments are given in the Appendix, Table 5. This irradiation process

TABLE 5

(from Brooks, Hannan and Hobbs)
Presence or absence of salmonellae in tins of frozen whole egg after irradiation with gamma rays.

Original contamination	*Dose (rads)*	*Salmonellae*
S.paratyphi B	300,000	–ve
S.newport	300,000	–ve
S.paratyphi B	400,000	–ve
S.newport	400,000	–ve
S.paratyphi B	500,000	–ve
S.thompson	500,000	–ve

therefore affords a unique method of treating frozen whole egg since it dispenses with the need to thaw or otherwise to handle the product.

The results of low dose irradiation (<1 megarad) on most other foods has been less successful. In most cases reported to the conference some extension of storage life at chill temperature was achieved, but the development during storage of 'off' flavours and odours with even these low doses made the foods, at best, noticeably different from untreated controls. The present status of irradiation research on the following commodities was reported: fish by Shewan, meat by Coleby, Radouco-Thomas, Schweigert, Steenberg Knudsen, Vidal; root crops by Horne and Hickman, Vidal; and wine by Schweigert, Stosic; fruit and vegetables by Clarke, Jensen, Vidal; milk and milk products by Freeman, Glew, Kraybill, Schweigert, Stosic; fruit and vegetables by Clarke, Jensen, Vidal; root crops by Horne and Hickman, Vidal; and wine by Stosic, Vidal.

The possible use of irradiation combined with other preservative processes was considered to offer the most likely method of extending the storage life of these commodities with the least change in their appearance, flavour, texture and odour, and Ingram described the general principles involved. For fish, Shewan reported that some of the more disagreeable odours and flavours resulting from irradiation can be minimised by a "tempering" technique (i.e. storage at temperatures of 7°C and above for a certain time followed by storage near freezing point.) In wines the converse of the general effects of irradiation was sometimes observed; for example Vidal reported that poor wines could, after irradiation, have the quality of good vermouth.

An application of ionizing radiations of considerable promise is in the field of insect and parasite control and to a lesser extent, in the control of sprouting in raw potatoes (Burton & de Jong). Disinfestation of foods and particularly grains was described by Cornwell, and the procedures showed the possibility of the control of pests which so far have resisted all other methods. The control of a specific case of parasitism in meat, *Trichinella* in pork, can be achieved with doses as low as 25,000 rads (Taylor).

Apart from changes in foods resulting from irradiation there are also changes in the packing materials, some plastic

films giving characteristic irradiation odours. Tripp from the U.S.A. gave an account of American experience in this field and although considerable progress had been made in increasing the resilience of plastic films, the development of 'off' odours following irradiation had not yet been prevented.

Fundamental aspects of the changes associated with irradiation processes were discussed by several delegates. A characteristic property of ionizing radiations is their ability to energize atoms, whether they occur individually or in combination, to such an extent that an orbital electron is ejected and a positively charged ion remains. This reaction is often written: $X \xrightarrow{M} X\uparrow + e$

The activities of the electron (e) cause further ionisations, the ions produced decomposing to give radicals. Consequently the papers describing the chemical changes resulting from the use of ionizing radiations, in aqueous systems by Weiss and in solvent systems by Uri, were chiefly concerned with the chemistry of free radicals. General biological aspects were described by Laser and special microbiological changes by Horne and Bridges, who have recently published a detailed account.[17]

Chemical changes in foods when microbiological spoilage is not limiting were described by Lea and particular changes in proteins after irradiation were reported by Schweigert and Kraybill. The main changes in the constituents of proteins after irradiation include deamination, decarboxylation and the formation of hydrogen sulphide and methyl mercaptan from the sulphur containing amino acids. Even with sterilizing doses, however, there has been no major destruction of amino acids, but profound changes in the physical and biological characteristics of the proteins have been observed. An example, described by Kraybill, of these changes is the reduced allergenic properties of irradiated milk.

Changes in enzymes were described by Marples and by Glew, in lipids by Coleby and in carbohydrates by Phillips.

The possible commercial application of any of the treatments described at the conference did not appear to be imminent in the member countries although it was stated by Kuprianoff that the use of ionizing radiations for the control of sprouting in potatoes had been permitted in the U.S.S.R. in the autumn of 1958 (at Geneva Conf.). A summary of the current legal position in Europe is given in the

TABLE 6

Legislation in Europe affecting the use of irradiated foods

Country	*General statement of national legislation*
A. No specific legislation	
France	Food irradiation is considered to be a chemical treatment and is forbidden. The ban extends to the sale of foods irrespective of their origin.
Italy	Consumer protected by current legislation.
Netherlands	The sale of irradiated foods could be prohibited under the General Municipal Food Inspection Decree.
Norway	All foods prohibited which are, or suspected to be, hazardous to health.
Poland	—
Spain	—
Sweden	Food may be condemned if it can be assumed to be dangerous to the consumer as a result of deterioration, contamination, faulty preparation or any other reason.
Switzerland	Foodstuffs which have been subjected to some physical processing may only be marketed after the process has been approved by the Federal Health Office.
United Kingdom	It is an offense to sell to the prejudice of the purchaser any food which is not of the nature. or not of the substance, or not of the quality demanded.
B. Specific legislation	
Germany	Ionising or ultra-violet radiations cannot be used without specific authority—none has yet been given.
c.f. U.S.S.R.	It is permitted to submit potatoes intended for human consumption to irradiation doses of up to 10.000 rads.

appendix in Table 6. The irradiation facilities for food research and their proposed development in the countries represented at the conference are outlined in Table 7. Work is in progress in the U.S.A., the United Kingdom, France and the U.S.S.R. on the wholesomeness of irradiated foods. This work involves the elaborate feeding and testing of several generations of different experimental animals and no final conclusions have yet been reached.

Quite apart from the legal aspects of irradiation is the question of the commercial suitability of the process. Neither electrical nor isotopic sources of ionizing radiations are suitable for small scale operation and neither can be installed or operated without the attention of highly skilled staffs. Furthermore, the danger to operators which could result from inadequate control of irradiating equipment cannot be overlooked. With these limitations in mind it is nevertheless quite conceivable that irradiation processes could be successfully incorprated into large modern broiler, turkey and egg processing plants. However, so long as irradiated foods require refrigeration, current technological aids in the poultry industry are likely to remain strong competitors. The ad-

TABLE 7

Present and proposed sources for the irradiation of foods in Europe*

Country	*Principal Centre*	*Present Sources*		*Proposed Sources*	
		Gamma rays	*Cathode rays*	*Gamma rays*	*Cathode rays*
Belgium	Centre d'Etude de L'Energie Nucleaire, Mel.	(i) Spent fuel elements (ii) Co^{60}—6,500 curie	—	1960 - highly enriched spent fuel elements to give peak dose rates of 10^7 roentgens/hr.	—
Denmark	Div. of Agricultural Res., AEC Research Establishment Risö, Roskilde.	Co^{60}—1,200 curie	—	Spent fuel elements	(i) 2-13 Mev. Linear accelerator
France	C.E.A., Service Biologie, Saclay.	(i) Spent fuel elements (ii) Co^{60} 2 x 600 curie	—	1959 3000 curie source	—
Germany	Bundesforschungsanstalt für Lebensmittelfrischhaltung, Karlsruhe.	—	(i) 1 Mev Linear Accelerator (120 Kv. X-ray units)	1959 Co^{60} 3-400 curie	—
Italy	Stazione Sperimentale Conserve, Via Tanara 33, Parma.	—	—	1959 Spent fuel elements	—
Netherlands	Institute of Atomic Sciences in Agriculture. Prof. Ritzema Bosweg 32, Wageningen	A source giving 1 Kg. dose of 10^4 rad/hr.	1 MeV Linear Accelerator	—	—
Norway	The Agricultural College of Norway	A small source	—	—	—
Poland	Agricultural Centre for Isotope Investigations, Warsaw.	A small source	—	—	—
Spain	Departmento Quimica Vegetal Pasco de Valencia al Mar. 13 Valencia	—	—	A source	A Linear accelerator
United Kingdom	Isotype Division, Wantage Radiation Laboratory, Wantage, Berks.	(i) Spent fuel rods (ii) Co^{60}—600 curie (iii) Co^{60}—4,500 curie	4 MeV Linear Accelerator	1959. Co^{60} - 150,000 curie to give a capacity of 50,000 lb. of food per week irradiated with a dose of 2 Megarad	—
Yugoslavia	Federal Nuclear Energy Comm., of F.P.R. of Yugoslavia. Kosancier Venac 29, Belgrade.	A small source	—	—	—

*Commercial sources not included

ditional storage life, without loss of quality, of broilers after treatment with tetracycline antibiotics is comparable with that resulting from "pasteurizing" irradiation treatments and the antibiotic process has the great commercial advantage that no change, apart from the purchase of the powder, need be made in current practice. Compared with the high capital expenditure necessary for the purchase of an irradiation source and the complexity of the equipment and its safeguard, this advantage is a considerable one.

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BOOM DEVELOPING IN CAMBODIA POULTRY FARMING

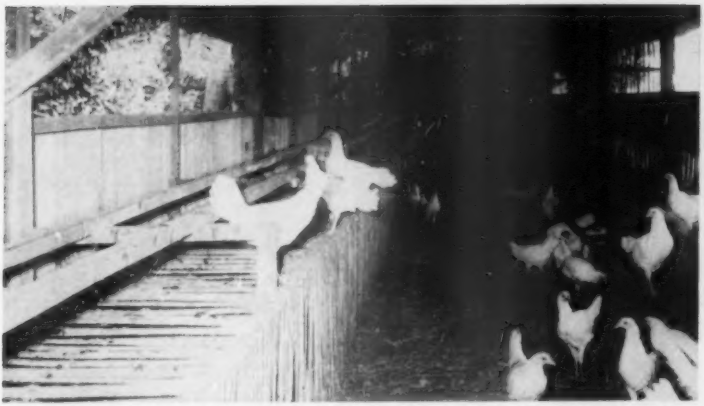
Increases in egg production up to 50 per cent and decreases in chicken mortality by almost a third are two of the interesting outcomes of a national poultry improvement program which has been put into effect by the Government of Cambodia with the help of an expert from the Food and Agriculture Organization (FAO), Rome.

The expert, Dr. Werner Thomann of Switzerland, who was sent to Cambodia in 1957, has concentrated on training Cambodian staff in modern poultry production techniques and has established demonstration centres where trials in improved management, feeding and breeding methods have been carried out. He has also organized training courses for students in agricultural and in veterinary science, as well as for school teachers and managers of poultry stations.

The background of this work in Cambodia is that many of the people of the country suffer from lack of protein in their diet, which results in malnutrition so often found in tropical and sub-tropical countries. Eggs and chicken meat are, of course, rich in protein and in other important nutriments. Eggs are of particular value in tropical climates because their shells protect their contents against both adulteration and deterioration. The chickens themselves provide fresh meat, and flocks can be quickly raised without high capital investment.

However, even chickens, which can stand unfavourable climatic and living conditions, need a certain amount of care and attention and nutritious feeding if they are to produce eggs. This is a fact not generally recognized in many countries and the peasants in Cambodia, for example, did not consider it necessary to provide houses and nest-boxes for their chickens, nor to feed the birds properly, As a result, their chickens laid an average of 60—80 eggs a year as compared with the 200—220 eggs laid by well-kept hens. Furthermore, the eggs produced were small and, because of their scarcity, expensive.

One of the first actions of the FAO expert in Cambodia was to investigate the situation in the Government poultry stations where he found that the housing cost per hen per year amounted to 600 riels (about $17). He was able to prepare better housing plans which reduced the cost per hen to



Interior of a small poultry house built only with local material. A hygienic feature to note is that the night droppings fall outside the poultry house through the bamboo laths.

The expert demonstrating to the personnel of the poultry station of Stung Mean Chey the collection of blood for the rapid pullorum test.

36 riels or less.

As so often on such assignments, the expert worked in cooperation with other international organizations so that, with the help of the United States Operation Mission, Dr. Thomann was able to import from Thailand and Japan hatching eggs of stock free from pullorum (white diarrhoea, a disease causing heavy losses among chicks). The United States Operation Mission also provided poultry equipment, including new incubators, which handled up to 12,000 eggs each, and modern feed mixers.

Local feeding stuffs, such as rice bran and fish-meal, were analyzed and new rations prepared, which were tested before being put into general use. Disease control and improved methods of management were introduced and, as a result of the various measures taken, hatching results were improved, mortality of chicks and chickens decreased and egg and meat production were increased.

These results have attracted widespread attention in Cambodia, stimulated by the distribution of mimeographed leaflets dealing with modern poultry production and blueprints for building cheap poultry houses and equipment. The result of the expert's work is probably best summed up by a report submitted to FAO headquarters by Dr. Thomann, who states:

"The development of poultry keeping in Cambodia is getting a boom-like appearance. Many people, seduced by the success of progressive farmers and governmental stations, want to start a poultry business, sometimes even on a big scale. A newspaperman, for instance, wanted to start a 20,000 hen farm. It was quite a problem to make him understand that beginners had to start on a much more modest scale. Fortunately, he was given only a test group of 100 baby chicks, which died within eight weeks because nobody took care of them. Most of the chicken customers, however, are much more lucky. Farmers in many places have reported excellent results which are, of course, the best propaganda for the poultry industry. Some peasants came over distances of 150 km. just to buy a few improved chicks. A new incubation station with a capacity of 23,600 eggs will soon be put into operation and I can now say that Cambodia is on its way to developing its own poultry industry which will grant additional income and contribute to solving the problem of lack of protein in the people's diet."

Feeding of the ready-to-lay pullets in the big poultry house.

Inspection of a flock of Leghorn pullets in the first Cambodian poultry farm.

LIQUID EGG ALBUMEN, AN EFFECTIVE DILUTER OF FOWL SEMEN FOR ARTIFICIAL INSEMINATION

M. L. SUBHANIDHI XUMSAI
Kasetsart University
Bangkhen, Bangkok, Thailand

Normal saline solution has for a number of years been used by the Poultry Section of Kasetsart University in diluting cock semen for artificial insemination and it is still being used now, in spite of the claim that injurious effects are produced on the lipid capsule of the sperm. From the results of the studies made in our laboratory (1957) on the use of different artificial diluents, normal saline solution, Ringer's solution, Tyrode's solution, Egg-Yolk citrate and liquid egg albumen, it was found that liquid egg albumen, if carefully prepared and the pH properly adjusted, could maintain the motility of the sperm up to 10 or 12 days whereas the normal saline solution could maintain the motility for only 24 to 27 hours. Judging from the persistence of motility and survival alone, liquid egg albumen should produce higher fertility in actual insemination than the normal saline solution.

Anderson (1945) cited the work of Milovanof who stated that it has been established for sperm that a certain amount of salts is necessary for normal irritability. Pure salts, however, have an injurious effect on the vitality, for in such solutions, the sperm move very actively and thereby lose motility and die. It is apparently associated with the removal of the electric charge of the lipoid capsule and a change in the state of its colloids. The most favorable media are, therefore, those which contain a moderate amount of electrolytes.

Regarding the influence of various ions on the motility and survival of the sperm, Milovanof emphasised the statement of Redenz that the ions influence not the sperm themselves but the colloids of the lipoid capsule. The ionic series obtained by various authors reproduce to a greater or less extent the lyotropic series of ions which illustrate the influence of ions upon the swelling of lyophyl colloids. Anions, like sulphate, tartrate, phosphate, and acetate (especially sulphate) prevents swelling and thus by reducing the destruction of the lipoid capsule delay the transition of spermatozoa into an irreversible state. Those, like chloride, chlorate, nitrate, iodide, and thiocyanate, aid the swelling of colloids and by

destroying the lipoid capsule causes the rapid death of the sperm. Anderson also cited the work of Dunbincik who found that among the anions, citrate, then iodide and chloride were the most injurious, while sulphate and tartrate appeared to have a favorable effect.

Salts such as chloride should not be used in diluting fluids. Physiological salt solution is stated by Milovanof to have a destructive action on the capsule, and it is for this reason that the method of determining the resistance of sperm, titration with 1 per cent NaCl is based. Both pure solution of NaCl and equilibrated by the addition of antagonistic cations, K, Ca, and Mg, have essentially similar effects on the capsule, which is regarded as the explanation of the injurious effect of various physiological salt solutions and also of accessory secretions.

Subhanidhi (1941) conducted an experiment on the storage of cock semen in normal saline solution, Ringer's solution and liquid egg albumen and found that liquid egg albumen could maintain the motility the longest, up to 72 hours.

Heiichiro and Masakatsu (1925) stored cock semen in Ringer's solution, liquid egg albumen, 0.75 per cent saline solution and 6 per cent dextrose solution at 10°C. and the motility could be maintained up to 60 hours, 26 hours, 16 hours and 12 hours; respectively.

OBJECT OF THE STUDY

On examining the incubation records kept by the College Hatchery from the year B. E. 2496 to 2501 (1953 to 1958), it was found that the average fertility of the eggs obtained was scarcely 60 per cent. This figure, however, appeared to be much lower than normal, which should not be less than 85 per cent, especially during the normal breeding season. As a consequence, the Poultry Section had to bear a great loss, estimated at not less than Baht 500,000 thru the infertile eggs. The former Rector, Dr. Luang Suwan, noting this great loss, had put the problem on the Department of Animal Husbandry. Studies on the artificial diluents were previously conducted from time to time by M. L. Subhanidhi Xumsai under the supervision of M. R. Chavanij Voravan and the instructive guidance of Dr. F. M. Fronda, Poultry Expert on Poultry Production attached to Kasetsart University. From the various experiments conducted in vitro on the storage of cock semen in different diluents, liquid egg albumen was found to maintain

the longest motility.

The question is, will liquid egg albumen produce maximum fertility in actual inseminations? In what respects is liquid egg albumen superior to normal saline? Will liquid egg albumen be a solution to the problem?

PREPARATION OF DILUTER

Medium sized freshly laid eggs varying in weights from 52 to 55 grams were used. The shells were cleaned with 70% alcohol to remove dirt and to disinfect surface contaminations. The contents were aseptically collected on a sterile gauze placed over the mouth of a beaker, allowing the thin liquid albumen to drain through the gauze into the beaker until the last drop was collected. The average amount of the liquid albumen obtained from one egg varied from 10 to 15 cc.

The initial pH of the liquid egg albumen as tested by the Beckman pH meter was 8.5 which rapidly increased to 9.1 in few hours. Equal amount of phosphate buffer as prepared by Philips was added and the pH was reduced to 7.5. The liquid egg albumen phosphate was further adjusted by M/10 citric acid to maintain the pH at 6.8 and stored in the refrigerator at 10°C. as stock diluter. This diluter could be stored for several weeks and still held good as fresh diluter for cock semen. For longer storage, antibiotics may be added at the rate of 200 to 400 i.u. per ml.

EXPERIMENTAL PROCEDURE

Experiment I: Fertility test in Single Comb White Leghorn layers using normal saline diluter.

A flock of 450 Single Comb White Leghorn layers in their second year of laying was used. These birds were individually leg-banded. Semen was collected from the roosters, pooled and diluted with equal parts of normal saline (1:1) diluter. Inseminations with diluted semen at the dosage of 0.10 cc were made in all the 450 layers, twice a week. Eggs collected

Table 1

Date of insemination	Diluter	Dilution	Number of eggs set	Fertility (percent)
6 Aug. 58	normal saline	1:1	485	13.6
9 Aug. 58	saline	1:1		
12 Aug. 58	saline	1:1	418	19.7
15 Aug. 58	saline	1:1		

from the following day after insemination to a period of 7 days were marked and incubated. Fertility was recorded for 10 days and the results are shown in Table 1.

The birds were withheld for 10 days and reinseminated with semen collected from the same group of S.C.W.L. roosters, diluted with liquid egg albumen from the prepared stock twice in the first week and once in the following week. Fertility was recorded for two weeks. Newcastle vaccination was made on the 27th August 58. The same dosage of 0.10 cc was used.

22 Aug. 58	liquid egg albumen	1:1	448	61.0
25 Aug. 58	albumen	1:1		
28 Aug. 58	albumen	1:1	596	50.2

Experiment II: Fertility test in White Leghorn x Rhode Island Red crosses using liquid egg albumen.

Ten selected White Leghorn roosters whose sperm count had been determined and recorded (not less than 3,000,000/mm) were used. Semen was collected from the roosters, pooled and diluted with the stock liquid egg albumen diluter in the dilution of 1:1. This diluted semen was inseminated into 94 Rhode Island Red pullets twice in the first week at 3 days interval and once in the following weeks. The dosage used was 0.10 cc. All the eggs were collected every day from the following day after insemination, marked and set in the incubator every 7 days. Fertility was recorded for six weeks and the results obtained are shown in table 2.

Table 2

Date of insemination	Diluter	Dilution	Number of eggs	Fertility (%)	Hatchability (%)
14 Aug. 58	liquid egg albumen	1:1			
17 Aug. 58	" albumen	1:1	369	94.30	81.89
24 Aug. 58	" albumen	1:1	429	95.80	74.69
31 Aug. 58	" albumen	1:1	584	82.87	86.57
7 Sept. 58	" albumen	1:1	487	90.00	91.30
14 Sept. 58	" albumen	1:1	440	88.61	87.69
21 Sept. 58	" albumen	1:1	364	84.07	86.93

All the chicks grew into a healthy flock and no mortality was reported.

DISCUSSION

The results as appeared in Table I certainly represent a significant improvement in fertility by using the liquid egg albumen as diluter. The fertility was increased from 13.6 and

19.7 percent to 61.0 and 50.2 percent on switching from using the normal saline diluter to the liquid egg albumen diluter. During the use of liquid egg albumen in the second trial, the birds were subjected to Newcastle vaccination which might have some effect on fertility.

In Table 2 of the experiment II, the figures secured were remarkable when another flock of Rhode Island Reds was inseminated with White Leghorn semen diluted with the liquid egg albumen. The fertility obtained was 94.3 percent for the first week, 95.8 for the second, 82.9 for the third, 90 for the fourth, 88.6 for the fifth and 84.1 percent for the sixth week. These high figures were obtained in spite of the normally low fertility during the season. Some of the birds started to moult during the latter month of the experiment.

The results of the experiment conducted showed conclusively that the use of liquid egg albumen is far superior to normal saline solution in many respects. The practice in the University was to inseminate twice a week. Since with the use of this diluter it was shown that only one insemination is required per week for profitable results. Also a considerable saving of time and labor is effected, and the roosters and the layers are subjected to less handling. The resulting excellent fertility of the eggs will produce more chicks and more income will accrue to the Poultry Section. If this diluter is used extensively, a considerable advantage will accrue to the poultry raisers of the country.

Considering that the cost of producing liquid egg albumen as a diluter is practically nil, only about 0.06 satang per insemination, there is no valid reason why this diluter should not be used in place of the saline solution. The extensive use of liquid egg albumen as a diluter of cock semen for artificial insemination will mark a new era in the poultry industry of Thailand. A considerable amount of money will also be saved by the reduction of infertile eggs that will be produced in many hatcheries of the country.

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"STRESS" AND ITS IMPLICATIONS IN POULTRY PRODUCTION

KEITH I. BROWN
Department of Poultry Science
Ohio Agricultural Experiment Station
Wooster, Ohio

The magnitude of the field has influenced me in the selection and presentation of material included in this discussion. Where to draw the line was often difficult and decided quite arbitrarily. Many aspects of the subject on which there is a large literature have received only brief mention and have been covered by reference to only a few papers.

A BRIEF INTRODUCTION TO "STRESS" AND THE CONCEPT OF THE GENERAL ADAPTATION SYNDROME (G-A-S)

One of the most universal attributes of living organisms is the tendency to maintain constant conditions in the body fluids (internal environment). One of the great physiologists of the past half century (1), summed up the body's constant vigilance in maintaining static conditions in the body fluids by use of the single word "homeostasis", which means very simply, unchanging internal environment. To maintain a state of homeostasis in the body, compensatory changes are initiated in response to any physiologic imbalance, whether induced by external environmental hazards, abnormal titers of hormones or nutritional factors or pharmacologic agents. If the stimuli are not too severe, adaptations go on quietly as a part of general life processes and no harmful homeostatic imbalances result. On the other hand, the damaging agent may be of such intensity or duration that homeostasis is not achieved and biologic harm results.

There are no entirely satisfactory definitions of the words "stress" and stressor as applied to biologic phenomena, however, most workers regard stress as *a harmful condition resulting from the inability of the organism to maintain an adequate internal environment.* A stressor is any agent capable of producing stress, and the target designates the tissue or the part of the body which is directly affected by the stressor. Thus cold, forced exercise, infections, and so forth, are potential stressors which may elicit conditions of stress within the body. Stressors such as irritants that cause mild inflammation, may produce only local damage and require no general adaptive reactions, whereas systemic stressors evoke generalized adap-

tive reactions in which the entire body participates.

When the organism is subjected to any kind of stressful stimulus, specific or non-specific adaptive reactions are elicited which bring about a type of adjustment. Specific adaptation involves adjustments which render the body resistant only to the exciting stressor and non-specific adaptation protects against many other stressors which are qualitatively different from the original one. Muscular hypertrophy following physical exercises and serologic reactions to particular antigens are adaptations of a specific nature. Stressors such as severe hemorrhage, burns and trauma provoke an entirely non-specific pattern of systemic adaptation which increases resistance to damage as such. It should be pointed out that severe stressors that provoke specific adaptation may concomitantly evoke non-specific adaptation. The endocrine system is of paramount importance in the non-specific adjustments which ensue regardless of the nature of the evocative stressor. The sum of all these non-specific systemic responses to stress has been termed, the General Adaptation Syndrome (G-A-S) (2).

The most prominent morphologic and functional changes which occur durng the G-A-S are: (1) enlargement of the adrenal cortex with an increase in the release of cortical steroids; (2) involution of lymphatic tissues with concomitant changes in blood cell count; (3) gastrointestinal ulcers (in mammals) and (4) variations in the resistance of the organism to stress. Fig. 1 shows the effect of a severe hock condition complicated by a staphylococcus infection on adrenal size in a turkey.

COURSE OF THE GENERAL ADAPTATION SYNDROME

It is now known that G-A-S evolves in three distinct stages, when the organism is exposed continuously to non-specific stressors. The stages of the G-A-S are as follows:

1. *The Alarm Reaction.* When the body is exposed suddenly to damaging stressors, a series of physiological alterations occur which represent either the direct results of damage of "shock", or attempts of the organism to defend itself against shock. When the stressful stimulus is not too severe, the alarm reaction evolves in two phases; the shock phenomena appear first followed by counter shock. The main symptoms of shock are diminished body temperature, hemoconcentration and a fall in blood pressure, decreased blood chlorides, increased capillary permeability, diminished basal metabolic rate and other signs

Figure 1. Macroscopic effects of stress (severe hock condition) on the adrenals of a turkey. Left, adrenals from a normal turkey. Right, adrenals from a stressed turkey. (magnification 3 X).

of systemic damage. Unless the shock proves fatal, a chain of reactions is elicited during the countershock phase which increases the resistance to stress. The principal alterations that occur during the countershock phase are increased release of ACTH (adreno-corticotrophic hormone) from the anterior pituitary, and a consequent augmented release of cortical steroids and an elevation of the blood chlorides.

In most cases there is an intermixture of shock and countershock reactions and under certain conditions the sequence of shock and countershock manifestations may be reversed. For example, if a stressor is first applied in mild form and gradually increased in intensity until it assumes fatal proportions, the countershock reaction appears first while the organism can still resist; as further resistance to the augmented stressor becomes impossible, the signs of shock predominate and death ensues. This latter form of mild stress applied continuously over a long period of time may prove to be of particular interest to the Poultry scientist working in the field of environmental physiology.

2. *The Stage of Resistance*: No organism can maintain itself indefinitely in a state of alarm. If it can survive in the presence of the stressful stimulus, it passes from a state of alarm into a state of adaptation or resistance. The adjustments initiated during the countershock phase of the alarm reaction gain supremacy, and the resistance is increased to the agent causing the stress.

The manifestations of resistance are usually opposite of those which prevailed during the alarm reaction. The basal metabolic rate returns to normal, body temperature rises, blood volume increases, blood chlorides return to normal, and so forth. During the alarm reaction the secretory granules of the adrenal cortex are depleted, but during the stage of resistance the gland becomes rich in these materials.

3. *The Stage of Exhaustion*: The fully adapted organism cannot maintain its resistance to harmful agents indefinitely. After prolonged stress the acquired adaptation is lost and the organism enters into a stage of exhaustion. The symptoms appearing during this stage are similar to those which characterized the initial alarm reaction, and death ensues unless the stressful stimulus is withdrawn.

ADAPTATION ENERGY

The inevitable breakdown of adaptive powers is interpreted as meaning an exhaustion of the organism's store of adaptation energy (3). This term is used to designate the ability to acquire resistance to stress. There is a great deal of variation in adaptive capacity among members of a species, and it is thought that genetic factors determine how much adaptation energy is apportioned to each individual. Whatever the total quantity possessed, it may be used sparingly during a quiet life under optimum conditions, or consumed rapidly in order to maintain life for a short period under severe and unrelenting stress.

The total amount of adaptive energy at the disposal of the organism is probably not absolutely limited. For example, continued exposure of an animal to a severe stressor; such as cold, will eventually lead to death. However, interrupted periods of relief from the cold restore considerable ability to resist and adapt to later exposures to cold. Although difficult to prove, it is probable that intermittent periods of severe stress do serve to shorten the life span of any animal.

If nothing else, the concept of adaptation energy provides the commercial poultryman a logical rationale for good management practices. Since the goal of the poultryman is not to increase the total life span of his flock, but to obtain optimum production of meat or eggs for a relatively short period of time during the life of the bird, it may be that some stress is beneficial.

THE GENERAL ADAPTATION SYNDROME AND INFLAMMATION

The gross manifestations of inflammation are swelling, redness, heat and pain. An abscess is formed eventually, and the disintegrated tissue is replaced by scar tissue.

It is well known that the rat is congenitally hypersensitive to egg white and that this foreign protein induces a marked inflammatory response when injected into a non-stressed animal. However, when the protein is injected into a rat which is in the alarm stage of G-A-S, the inflammatory reactions are greatly diminished. Adrenalectomy increases the sensitivity of the organism to egg white, whereas adrenocortical extracts restore resistance to normal. Without enumerating further examples it will suffice to state that the glucocorticoids released during the G-A-S decrease the inflammatory potential of all tissues of the body, and thus prevent the normal degree of inflammatory response to such irritants as allergens, trauma, pharmacologic agents, etc. Conversely, mineralocorticoids which are not normally released in increasing amounts during the G-A-S, inhance the inflammatory potential of all tissues of the body. An impressive amount of evidence has been assembled, suggesting that during prolonged stress the adrenal cortex, and perhaps the anterior pituitary gland, may release an excess or an imbalance of hormones and thus play an etiologic role in certain human diseases which are inflammatory in nature (4). Such diseases as hypertension, arthritis, arteriosclerosis, periarteritis nodosa, nephritis, and many others fall in this category. The concept of the so-called *diseases of adaptation* has thus far received very little attention in the field of poultry science.

DYNAMICS OF THE ADAPTATION SYNDROME WITH SPECIAL REFERENCE TO BIRDS

Catabolic processes are accelerated, during stress, and this leads to a profound loss of living substance throughout the body. All tissues shrink in weight except the adrenal cortices. These glands continue to enlarge, become hyperemic, and appear to be the only tissue that really thrives on stress, (Fig. 2). Thus attention was directed first to these glands as possible links in the chain of reaction leading to the stress syndrome.

ADRENALECTOMY AND REPLACEMENT BY CORTICAL HORMONES

A full study of the metabolic consequences of adrenal-

ectomy has not been made in birds. There is no doubt that the gland is necessary for continued survival of the bird and death after the operation is generally rapid (5, 6, 7, 8, 9, 10, 11). Adrenalectomy is, however, a difficult operation in the bird, the gland being located close to main blood vessels and to the kidneys and lungs. The terminal symptoms are normally muscular weakness, decreased blood glucose, decreased body temperature, hemoconcentration and finally convulsions. These symptoms are similar to those appearing during the shock phase of the alarm reaction.

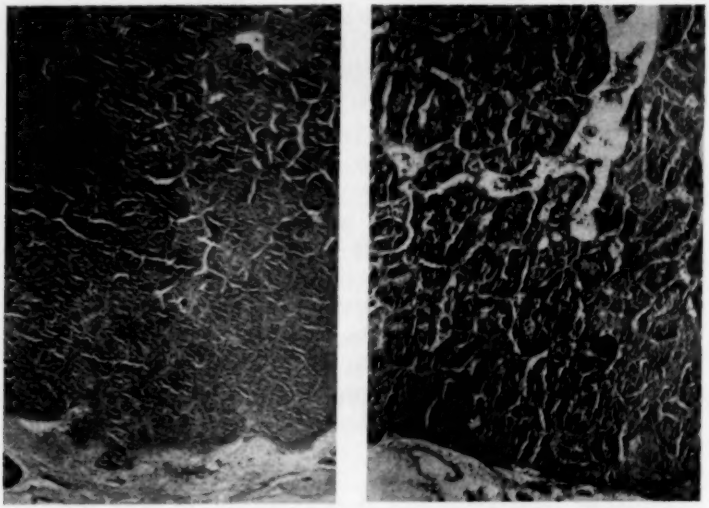

Figure 2. Microscopic effects of stress (severe hock condition) on the adrenals of a turkey. Left, adrenal from a normal turkey. Right, adrenal from a stressed turkey. Note the enlarged sinusoids (blood spaces) and apparent hypertrophy in the tissue to the right. (magnification, 37 X).

The adrenalectomized bird can be maintained in an apparently normal condition by the administration of adrenocortical extracts or by pure crystalline corticosteroids. Adrenalectomy in chickens does not prevent the drop in blood volume and consequent drop in blood pressure, decreased body temperature and other normal signs of shock produced by the stress of surgical trama (11). In fact such animals are much less capable of resisting shock than normal controls. Administration of adrenal cortical steroids (cortisone and desoxycorticosterone acetate) prevented the typical shock symptoms.

It appears that normally the adrenals of birds, as with mammals, release adaptive hormones which tend to counteract shock produced by a severe stress.

HYPOPHYSECTOMY AND REPLACEMENT THERAPY

Hypophysectomy (removal of the hypophysis or anterior pituitary) of birds has been reported by a number of workers (12, 13, 14, 15, 16, and 17). All workers report adrenal atrophy following hypophysectomy. The adrenals can be returned to normal size by injection of pituitary extracts (primarily ACTH). Hypophysectomized chickens (18) subjected to cold stress exhibit typical shock symptoms, while intact chickens subjected to the same treatment do not. The shock symptoms can be prevented by adrenocorticosteroid injection. The author has made similar observations with hypophysectomized turkeys. In the latter instance, the shock symptoms were alleviated when the birds were placed in a warm room, thus in effect removing the cold stress. It has been demonstrated that intact chickens respond to the stress of surgical trauma by an increased secretion of glucocorticoids, whereas, this response was prevented by hypophysectomy (11).

It can be concluded that in birds, as in mammals, the shock symptoms induced by severe stress are counteracted by the release of ACTH from the pituitary and the consequent release of adaptive hormones from the adrenal cortex.

THE IMPLICATIONS OF STRESS PHYSIOLOGY IN POULTRY PRODUCTION

An accelerated release of hormones from the pituitary-adrenal system occurs during every type of severe stress condition so far investigated. This is a useful response, inasmuch as it tends to maintain biological homeostasis during periods of stress. In the absence of either the pituitary or the adrenal cortex, the usual alterations fail to occur and the ability to tolerate stress of any kind becomes extremely low.

Since the time of Pasteur medical thought has been dominated by the view that each individual disease has its own specific etiological agent. In the field of immunology it is well known that the organism can develop specific defensive reactions against specific pathogens. The concept of the G-A-S permits a new interpretation of certain non-specific diseases. It holds that many diseases are not caused by any specific pathogen, but result from exposure to non-specific stress

and/or stressors and from pathogenic situations which ensue as a consequence of inappropriate responses to damaging agents. It is suggested that such poultry diseases as, hemorrhagic syndrome, dissecting aneurism and cage fatigue may fall in this category. A great deal of new information which can only be gained by research on stress, is needed before any of these diseases can be classified as diseases of adaptation.

There is a paucity of knowledge concerning what is or is not a stress in poultry. Future research should be directed toward developing criteria for measuring the intensity or severity of such stressors as cold, heat, feed additives, and so forth. Analysis of fowl plasma (19) indicates that the primary adrenal steroid present is corticosterone followed by much smaller amounts of hydrocortisone, cortisone and aldosterone. The author (unpublished) has confirmed that corticosterone is the primary adrenal steroid produced by the turkey. There are several quantitative micro-methods based on fluorescence of corticosterone in sulfuric acid (20, 21, 22) thus making it possible to routinely measure this steroid in fowl blood. Much research is needed to determine what stressors (cold, heat, drugs, forced exercise, and so forth) will cause an accelerated release of hormones by the adrenal cortex of birds. Research is needed to determine if the ratio of steroids produced by the adrenal cortex changes with the application of various types of stressors. Much work is needed to determine the physiological alterations that occur with changing elevated blood levels of the adrenal steroids. The researcher should strive to discover if correlations exist between these alterations and growth, feed efficiency, reproductive performance, and so forth.

If future research suggests that any condition that will cause an accelerated release of adaptive hormones from the pituitary-adrenal system is potentially damaging to the animal, then it follows that any agent or environmental condition that will produce this effect would be potentially damaging to the bird. Thus, the environmental physiologist could use an accelerated release of adaptive hormones as his criteria for determining what environmental conditions are potentially hazardous to the animal. Perhaps the nutritionist could likewise use this as a criteria for determining what feed additives

or levels of feed additive are potential stress factors for the animal.

Perhaps the geneticist can determine the heritability of adrenal weights or the ability of an animal to respond to stressful stimuli by an augmented release of adaptive hormones under stress conditions. If the heritability is relatively high, perhaps it will be possible to select animals with superior resistance to a wide variety of environmental hazards and disease conditions. The farsighted producer of the future may not be satisfied with selecting individuals, but may want to institute breeding programs calculated to increase the proportion of individuals that are resistant to a wide variety of stress conditions. This is a matter of first being able to recognize the desirable individuals, whether foundation stock or progeny, and secondly of applying genetic principles. Obviously much basic information concerning stress physiology in the fowl must be gathered before such a program will be feasible.

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THE REQUIREMENT OF POULTRY FOR ZINC*

J. E. SAVAGE and B. L. O'DELL
University of Missouri, Columbia, Mo., U.S.A.

For the past 20 yrs. or more, the trace element zinc has been assumed to be a dietary essential for poultry and most salt mixes used in purified diets during this time have supplied about 5 to 7 mg of zinc per kg of diet. The common trace mineral mixes formulated for use in practical poultry feeds supply somewhat less than 1 mg of zinc per kg of feed.

The assumption that zinc is essential for poultry has been based for the most part on the observations of Todd *et al* (1934) and Stirn *et al* (1935) that zinc was essential for growth in the rat. Indirect evidence for its essential role in poultry came from the discovery that zinc was present in the prosthetic group of several enzymes, notably carbonic anhydrase (Keilan and Mann 1939) and carboxypeptidase (Vallee and Neurath, 1955). The presence of zinc in carbonic anhydrase, therefore, involves this element in processes concerned with calcification of bone and deposition of the egg shell. It was shown by Common (1941) that the concentration of carbonic anhydrase in the uterine region where shell deposition takes place was almost twice as high in a laying hen as it was in a non-layer. Benesch *et al* (1944) and Gutowski and Mitchell (1945) also demonstrated that carbonic anhydrase was involved in normal egg shell deposition. Observations made on animals after the ingestion of $zinc^{65}$ show that zinc is concentrated in the hair, liver and bones (Perkins and Nielsen, 1959). Tupper *et al* (1954) found zinc concentrated in the yolk protein fraction of the egg after the injection of $zinc^{65}$-glycine while none could be detected in the albumen or shell.

Despite the wealth of circumstantial evidence which pointed to the probability of zinc being essential for poultry, numerous studies have failed to show a beneficial effect from the inclusion of zinc supplements in poultry feeds. Titus (1932) added 0.001% zinc as zinc acetate to a diet on which a high level of perosis occurred and found the zinc supplement did not prevent the occurrence of abnormality. Wilgus *et al* (1937) thought that zinc supplements reduced the incidence of perosis in their experiments but that the zinc supplement was less effective than manganese. In contrast, Insko *et al*

* Reproduced from the 14th Distillers Feed Conference, 1232 Enquirer Bldg., Cincinnati 2, Ohio

(1938) concluded that 30 mg per kg of aluminum and zinc added to a ration low in calcium and phosphorus appeared to increase the incidence of perosis rather than to decrease its occurrence. Slinger *et al* (1956) added zinc supplements of 25 and 50 mg per kg to practical diets for turkey poults and reported that the addition of the zinc supplement increased the growth of males but not females. When the diet was further supplemented with 25 mg per kg of aureomycin, zinc had no significant effect on growth. The zinc supplement also had no effect on a dermatitis condition affecting the bottom of the poults' feet. Mehring *et al* (1956) added graded levels of zinc, 15 to 778 mg per kg, to a corn-soy broiler diet that contained about 40 mg per kg of zinc and observed no effect on growth or feed efficiency.

CHICKS

Studies concerned with mineral requirements of poultry were stimulated by the concurrent reports of Dannenburg *et al* (1955) and Morrison *et al* (1955) that an unidentified mineral was required by the chick. Both groups of investigators used diets containing an isolated soybean protein (Drackett C-1 Assay Protein). Dannenburg and co-workers found that the ash of corn Distillers Dried Solubles added to this diet would produce a growth response which was equal to approximately half of that obtained with the unashed sample used as a source of unidentified growth factor activity. Morrison and his associates observed similar effects when the ash of a mixture of crude products was added to the basal ration. Other reports of unidentified growth effect in the ash of various crude products were those of Tamimie, 1955; Benton *et al*, 1955; Lillie *et al*, 1955; Camp *et al*, 1956 and Menge *et al*, 1956.

In studies aimed at characterization of the mineral, Norris *et al* (1956) reported it to be insoluble in hot water and cationic in nature.

The decrease in growth rate reported by Dannenburg *et al* (1955) when high levels of calcium were added to a diet containing an isolated soybean protein led workers at Missouri to test higher levels of zinc as a supplement in similar diets (O'Dell and Savage, 1957a). These tests showed that a diet similar to that of Dannenburg *et al* (1955) was deficient in zinc and further indicated that zinc was responsible for a portion of the unidentified mineral activity found in corn

Distillers Dried Solubles. These tests also indicated that much higher levels of zinc are required for this type diet than the 5-7 mg per kg supplied by the salt mixtures commonly used in purified diets.

Additional studies of the relationship of zinc to the unidentified growth factor found in corn Distillers Dried Solubles were reported by O'Dell and Savage in 1958. Chicks maintained in batteries that were treated with lacquer to reduce access to zinc coated surfaces and allowed only distilled water in glass or plastic fountains developed severe symptoms of a zinc deficiency when fed purified diets low in zinc. The ash of corn Distillers Dried Solubles partially counteracted the deficiency symptoms but zinc supplements were much more effective. When adequate zinc was present in the diet the ash of corn Distillers Dried Solubles had no additional effect on the growth rate. However, when the intact corn Distillers Dried Solubles was added to the basal diet the chicks were slightly but consistently heavier than chicks which received the basal diet plus adequate zinc or the basal diet plus zinc and the ash fraction. This stimulation in growth produced by corn Distillers Dried Solubles can be interpreted as evidence for an unrecognized organic growth factor in the intact product but the possibility also exists that it may be due to a mineral or minerals lost during the ashing procedure. The above observation of growth stimulating activity in corn Distillers Dried Solubles in addition to that present in the ash fraction is in agreement with studies at Texas and Cornell which were reviewed last year during this conference by Reid *et al* (1958).

The reports from the Missouri Station (O'Dell and Savage, 1957b, 1958) described for the first time specific zinc deficiency symptoms in chicks. A mild deficiency included slow growth, shortening and thickening of the long bones, development of frizzled feathers, an abnormally high respiration rate and an unsteady gait. The more severely depleted chicks exhibited these symptoms but to a greater degree and in addition developed a keratosis of the skin and an increased packed red cell volume. When chicks were maintained in lacquer-treated batteries and fed the C-1 Assay Protein diet with 1.6% calcium and 0.7% phosphorus the zinc requirement was estimated to be 35 mg of zinc per kg of ration. This requirement was decreased slightly by lowering the calcium to 1.1% but did not appear to be increased at a dietary level of 2.1%

of calcium. In the presence of adequate zinc the chicks grew equally well at all calcium levels. It was also observed (O'Dell and Savage, 1957b) that the requirement was less on a diet in which C-1 Assay Protein was replaced by casein. Additional observations on the symptoms of zinc deficiency and the effect of zinc supplements on growth have since been reported by Roberson and Schaible, 1958a, b; Edwards *et al*, 1958; Young *et al*, 1958; Pensack *et al*, 1958, Moeller and Scott, 1958 and Supplee *et al*, 1958.

TURKEYS

Supplee *et al* (1958) found that poults fed a sucrose-soybean protein ration required zinc supplements for rapid growth, normal bone formation and feather development. In a later report, Supplee *et al* (1958) found supplementary zinc was required for battery reared poults fed purified diets containing an isolated soy protein, casein or soybean oil meal. An additional observation of these workers was that the enlarged hocks observed on the basal diet were found only rarely in birds fed a diet which had been steam treated. Turkey broilers maintained on litter and fed practical rations weighed more in 9 wk if 48 or 96 mg per kg of zinc were added to the ration. In a 4-wk trial in batteries, however, growth was not improved when zinc was added to a corn-soy type ration. Confirmatory results on the requirement of the turkey poult for zinc have been reported by Kratzer *et al* (1958) and Norris and Zeigler (1958).

BROILERS

In work cited previously, Mehring *et al* (1956) added graded levels of zinc to a corn-soy broiler diet that contained about 40 mg per kg of zinc and observed no effect on growth or feed efficiency. Supplee and co-workers (1958) fed a supplement of 48 mg per kg of zinc in a practical broiler test and found that the zinc supplement did not improve either growth or feed efficiency.

LAYING HENS

Only a limited amount of information is available on the effect of zinc in laying hen diets. In a preliminary report Supplee *et al* (1958) found that zinc supplements improved hatchability and slightly increased the shell thickness of hens kept in batteries and fed an isolated soy protein diet. In layers maintained on the floor a supplement of 48 mg per kg of zinc did not improve production or shell quality during 24 wk of production.

CURRENT RESEARCH

Studies which are currently in progress at the University of Missouri are concerned with the effect of zinc in laying hen diets and practical chick rations.

The practical chick and broiler rations used are shown in table I and are a corn-soy type with and without an unidentified growth factor (UGF) supplement. The UGF supplement is a mixture of 3% of fish solubles, 3% of partially delactosed whey and 5% of corn Distillers Dried Solubles. Adjustments were made in the corn and soybean oil meal content of the basal ration so as to equalize the protein content when

TABLE I

Composition of Chick and Broiler Basal Rations

Ingredients	Chick[1] %	Broiler[1] %
Ground yellow corn	59.5	55.07
Soybean oil meal, solvent, 44%	36.0	35.50
Animal fat, stabilized	.....	3.00
Dehydrated alfalfa meal, 17%	.....	2.00
Vitamin E mix, 20,000 I.U./lb.	.05	.....
Vitamin K mix, 8,000 mg/lb	.025	.....
Coccidiostat[2]	.....	+
UGF supplement[3]	4.5	4.5

[1] The following ingredients were included in all chick (battery) and broiler (floor) rations: Dicalcium phosphate (18.5% P) 2.0%; ground limestone 1.3%; iodized salt 0.5%; vitamin A and D mix (1500 I.U. vitamin A and 300 I.C.U. vitamin D/gm) 0.3%; penicillin-vitamin B_{12} mix (2.0 gm procaine penicillin and 3.0 mg vitamin B_{12}/lb) 0.1%; DL-methionine 0.1% and B-mix (2.0 gm riboflavin, 4 gm calcium pantothenate, 10 gm niacin and 109 gm choline chloride/lb) 0.1%.

[2] Added at level recommended by manufacturer and replaces an equal amount of corn.

[3] UGF supplement: 5.0% corn Distillers Dried Solubles. 3.0% fish solubles, 3.0% dried whey. In rations containing the UGF supplement, adjustments were made in the corn and soybean levels of the basal ration to equalize the protein content.

these supplements were included in the ration. This mixture has been our most consistent source of growth promoting activity in trials conducted over the previous 3 yr. Like most investigators in the field of unidentified growth factors the response we observe with any of these supplements varies from time to time. In almost all trials, however, the weights of chicks which receive the above mixture will either be equal to the controls or superior up to the point of significance. If the UGF supplement did not possess a real growth promoting activity we would expect that the average weights of chicks receiving UGF supplement would be below the average of the basal ration in some trials, but this rarely ever happens.

The usual corn-soy practical chick ration will contain

from 30 to 45 mg per kg of zinc and judging from our tests with purified diets this should be adequate for growth providing all of the zinc is available and the chicks have access to additional zinc through the drinking water supply and galvanized equipment. Our observation (O'Dell and Savage, 1957b) and those of Edwards *et al* (1958), Moeller and Scott (1958) and Norris and Zeigler (1958), indicate that different protein sources vary with respect to the availability of zinc. When the corn-soy basal diets used in UGF studies are on the border line in meeting the requirement for zinc and if the zinc in some rations is less available than indicated by chemical analysis, then there is a possibility that some of the unidentified growth factor activity of certain UGF supplements may be due to the zinc furnished by these supplements. For this reason we have recently studied the effect of adding zinc supplements to the basal ration and UGF supplemented ration of chicks maintained in batteries and on the floor. Rations have been made up from practical ingredients and chicks were allowed access to the usual galvanized feeding and watering equipment except where indicated.

ZINC SUPPLEMENTS IN PRACTICAL CHICK RATIONS

The chicks used in all battery and floor trials were commercial broiler crosses of Dominant White Cornish x White Rock breeding. Zinc carbonate was used as a source of zinc in all of the trials reported but other work which is not shown here indicated that zinc was equally available from zinc chloride and zinc oxide. Zinc sulfate was also equal to zinc chloride in the work of Roberson and Schaible (1958b).

The results of two 4-wk tests with chicks maintained in galvanized batteries and which received tap water in galvanized troughs are shown in table II. As might have been

TABLE II

Effect of Zinc Supplements in Chick Rations

Treatment	4-Week Weight	
	Trial 1	Trial 2
	gm	gm
Basal corn-soy	434[1]	454[2]
+ 55 mg/kg Zn	448	453
+ UGF[3]	432	456
+ UGF + 55 mg/kg Zn	467	490

[1] Av wt of males plus av wt of females divided by 2; 20 straight run chicks per group.
[2] Av wt of 20 males per group.
[3] 5% Corn Distillers Dried Solubles, 3% dried whey, 3% fish solubles.

expected, under these conditions the growth rate of chicks which received the basal diet plus zinc was no better than that of the controls. Contrary to expectations, the addition of zinc to the diet which contained corn Distillers Dried Solubles, dried whey and fish solubles improved the growth rate of both trials.

Additional work on the effect of zinc supplementation of the basal corn-soy diet is shown in table III. In these 3 trials the chicks were maintained in lacquered batteries, feeders

TABLE III

Effect of Zinc Supplements in a Corn-Soy Diet[1]

Treatment	4-Week Weight[2] (gm)		
	Trial 3	Trial 4	Trial 5
Basal corn-soy	446	521	460
+ 55 mg/kg Zn	498	514	467

[1] Lacquered batteries and feed troughs. Distilled H_2O in glass and plastic fountains.
[2] 10 Males per group.

were lacquered and they were given distilled water in glass or plastic fountains. Despite the measures taken to reduce zinc contamination from the environments to a minimum, a clear cut zinc deficiency was not produced. In trial 3 the zinc supplement produced an increase in the growth rate but in trials 4 and 5 this effect was not observed. The reason for these differences in response is not readily apparent. In trials 3 and 4 other chicks that received the same management and fed an isolated soy protein basal diet developed severe symptoms of zinc deficiency. This would tend to rule out management and source of chick variation as being the cause. We have also observed that carry-over of zinc in the newly hatched chick has relatively little effect since chicks begin to show marked symptoms of zinc deficiency within the first week after being placed on the zinc deficient diet. This has also been observed by Edwards *et al* (1958).

During the course of these studies zinc analyses were obtained on a number of the ingredients used. Considerable variation exists among ingredients and some ingredients show considerable variation from sample to sample. The average zinc analyses of several ingredients as determined in our laboratories are shown in table IV. In most instances use of these values to calculate the zinc content of a ration gave values that agreed quite closely with the zinc content as determined by analysis. For purpose of comparison, also listed in table IV, are

TABLE IV

Zinc Content of Feedstuffs

Ingredient	Zinc (mg/kg)			
	(a)	(b)	(c)	(d)
Alpha Protein	16	....	.....	57
Alpha Protein, washed[1]	27	....	.....	42
Casein, crude	60	....	.....	111
Casein, washed[2]	45	....	.....	....
C-1 Assay Protein	34	....	.....	68
C-1 Assay Protein, washed[3]	43	....	.....	....
C-1 Assay Protein, washed	....	....	.....	47
Cerelose	less than 1	....	.....	....
Soybean oil, crude	6	....	.....	....
Gelatin	4	....	.....	4
Alfalfa meal, dehydrated	30	32	18.9	....
Animal fat, stabilized	9	....	.....	....
Corn, ground or meal	30	31	23.4	....
Corn Distillers Dried Solubles	70	110	89.6	....
Dicalcium phosphate (18.5% P)	78	0	.....	....
Fish meal	61	64	95.6	....
Fish solubles, dried	100	....	.....	....
Fish solubles	....	....	17.0	....
Limestone	13	4	.....	....
Soybean oil meal, 44%, solvent	68	....	66.4	....
Soybean oil meal, 50% protein	....	....	66	....
Whey, dried, partially delactosed	10	....	7.0	....

(a) Determined by polargraphic analysis by Dr. E. E. Pickett, Station Laboratories, University of Missouri.
(b) Leucke *et al* 1956.
(c) Norris and Zeigler 1958.
(d) Edwards *et al* 1958.
[1] Washed one time with tap water heated to boiling and twice with cold tap water at pH 4.6.
[2] Stirred in boiling tap water at pH 9.0, reprecipitated with HCl and washed 10 times with tap water at pH 4.5.
[3] Washed 3 times with 5 volumes of tap water and once with distilled water.

values reported by other laboratories for some of the same ingredients.

In the broiler trials summarized in table V, the addition of the UGF supplement to the basal corn-soy diet resulted in an improvement in growth rate in all trials. The zinc supple- received the UGF supplement. Slight but insignificant increases in growth rate were observed in 3 of the remaining 4 groups. In all but 1 trial the UGF supplement produced a more rapid rate of growth than zinc alone. It is apparent that the zinc supplied by the UGF supplements can be only partially responsible for the growth promoting activity of these supplements. The effect of the UGF supplement in broiler rations confirms the previous observation of O'Dell and Savage (1958) that corn Distillers Dried Solubles further improves ment produced a significant growth improvement in 1 group of chicks fed the corn-soy basal ration and in 1 group that

TABLE V

Effect of Zinc in Broiler Rations

Treatment	Trial 1		Trial 2		Trial 3	
	Wt[1]	Feed efficiency	Wt[2]	Feed efficiency	Wt[2]	Feed efficiency
Corn-soy basal	2.73	2.52	3.17	2.14	3.03	2.45
+ 55 mg/kg Zn.	2.77	2.47	3.23	2.16	3.12	2.32
+ UGF[3]	2.90	2.53	3.37	2.13	3.18	2.24
+UGF + Zn	3.00	2.40	3.39	2.10	3.13	2.18

[1] Average of duplicate pens of 50 sexed males and 50 sexed females per pen.
[2] Average of duplicate pens of 50 males per pen.
[3] 5% Corn Distillers Dried Solubles, 3% dried whey, 3% fish solubles.

the growth rate when added as a supplement to a ration adequate in zinc.

LAYING HENS

In the fall of 1957 three groups of pullets were started on a test to determine the effect of zinc in the laying ration. During the growing period these pullets were on wire floors and were fed a purified diet based on soy protein (Alpha Protein) and glucose that contained about 15 mg per kg of zinc. Feed and water were supplied in galvanized feeders and waterers. At the beginning of the test the birds were placed in individual laying cages and the cages of the birds which received the low-zinc diet were lined with bronze screening. They were fed in wooden feeders and supplied with tap water. After allowing several weeks for the birds to become accustomed to their environment they were started on test in December of 1957. The basal laying ration fed to 11 pullets was an Alpha Protein-glucose diet that contained approximately 10 mg per kg of zinc. Another group of 12 pullets received this same ration plus 110 mg per kg of zinc and a third group of 12 birds which received a practical all-mash ration served as the positive controls. The average egg production and egg weight for these birds for a 36-wk period are shown in table VI. During this period the pullets that received the zinc supplement laid 5.8% more eggs than those on the basal diet but produced 1.9% less eggs than the pullets on the practical control. Egg size also seemed to be affected by the treatment. The basal plus zinc fed groups laid eggs that averaged 1.5 gm more than the basal fed group but 1.5 gm smaller than the practical controls.

After 36 wk the basal ration was modified by substituting C-1 Assay Protein for the Alpha Protein in the diet and increasing the $CaCO_3$ level from 2.0 to 5.0% of the ration. The

TABLE VI

Effect of Zinc Supplements on Egg Production

Treatment	Period 12/7/57 — 8/9/58				Period 10/4/58 — 12/6/58				
	No. hens	No. eggs	Prod	Egg[1] wt	No. hens	No. eggs	Prod	Egg[2] wt	Shell thickness
			%	gm			%	gm	0.001 in
Purified basal, Alpha-Protein	11	1439	51.0	48.8	....	.....	.....	.....	.....
Alpha-Protein basal + 110 mg/kg Zn	12	1717	56.8	50.3	....	.....	.....	.....	.....
Purified basal, C-1 Assay Protein	....	.....	.....	.....	6	156	41.3	57.5	12.2
C-1 Assay Protein basal + 110 mg/kg Zn	....	.....	.....	.....	6	178	47.1	60.1	12.7
Practical control	12	1776	58.7	51.8	12	359	47.5	59.0	13.4

[1] March egg weight.
[2] December egg weight.

results of feeding this diet for 9 wk are also shown in table VI. Since some of the birds were nearing the end of their laying year and going out of production, the birds on the purified diets were reduced to the 6 birds showing the best production rates. The control birds were the same as were used in the earlier period. In this period the zinc supplement again appeared to improve production and egg weights were also slightly higher. Shell thickness measurements indicated that the zinc supplement had the effect of increasing shell thickness slightly but was still inferior to the practical ration in this respect.

Despite the very low levels of zinc in the basal diet the pullets showed no external symptoms of a zinc deficiency at any time during the trial. Feathering appeared normal and no differences in occurrence of molt were evident. The incidence of soft-shell eggs also was no higher on the basal diet than on the basal plus zinc or practical control. It is quite apparent that the requirement of the laying hen is much lower than that of the growing chick. Further studies are planned to obtain additional information on the requirement for egg production and to study the effect of the low zinc diet on hatchability.

ZINC SUPPLEMENTATION OF PRACTICAL RATIONS

In all reports where definite symptoms of a zinc deficiency have been described it has been necessary to use purified diets of low zinc content and to take special precautions to eliminate contamination from extra-dietary sources such as galvanized feeders, watering pans and brooder pens. Since these obvious deficiency symptoms do not appear in practical rations, the beneficial effect of a zinc supplement must be evaluated by the magnitude of growth response produced in chicks and growth and perhaps the feathering in turkey poults. Most of the experiments reported to date indicate that the majority of practical rations furnish sufficient zinc. However, an occasional response to zinc supplementation suggests that either some rations are borderline in zinc content or that lack of availability may be a variable factor. Under these conditions one may not wish to depend on obtaining needed zinc from the galvanized equipment and other environmental sources and should consider including a zinc supplement in the ration.

All classes of poultry tested so far tolerate levels of zinc which are on the order of 10 times the apparent requirement

without showing toxic effects. It is suggested that during the process of determining the minimum levels of zinc required by the various classes of poultry that 50 mg per kg of zinc can be considered a satisfactory level for addition to chick and laying hen diets and 100 mg per kg levels for growing turkeys. Zinc in the form of the oxide, carbonate, sulfate or chloride appears to be equally available for poultry.

SUMMARY

Zinc has been shown to be a dietary essential for poultry. On zinc deficient diets the characteristic symptoms which develop in chicks include slow growth, shortening and thickening of the long bones, development of frizzled feathers, an abnormal respiration and in severely deficient chicks, keratosis of the skin. Turkey poults fed the deficient diet develop enlarged hocks and exhibit poor feathering. Laying hens fed low zinc diets similar to those fed to chicks show no gross symptoms of a zinc deficiency but their rate of egg production is slightly lower and they produce somewhat smaller eggs which have thinner shells.

Practical rations appear to be improved by zinc supplements under some conditions. Pending final studies on the requirements for each class of poultry it is suggested that the addition of 50 mg per kg of zinc to diets for growing chicks and laying hens and 100 mg per kg to turkey diets will eliminate dependence on galvanized equipment as a source of this dietary essential and at the same time serve as a safety factor for varying degrees of availability in the ingredients of the ration.

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NEW FINDINGS ON THE ROLE OF FAT IN POULTRY NUTRITION*

L. C. NORRIS, RICHARD DAM, T. S. NELSON
and D. T. HOPKINS
Cornell University, Ithaca, New York, U.S.A.

Evidence has accumulated during the past few years which shows that some fats possess unidentified properties which stimulate chick growth and increase egg weight. These properties are possessed in particular by fats of vegetable origin. They appear not to be due to content of essential fatty acids or to the caloric value of the fats. To what extent fats obtained from animal tissues possess these properties is not known at present, but the available evidence indicates that occasionally, at least, they are less effective than the vegetable fats which have been studied.

The purpose of this paper is to discuss the unidentified biological properties of fats, and to differentiate the effects obtained with them from the requirement for the essential fatty acids and the effects derived from energy content.

NEED FOR ESSENTIAL FATTY ACIDS

The results of research work in which either fat-extracted or fat-free diets were fed show that, although the essential fatty acids (linoleic, linolenic and arachidonic acids) are probably required by the chick, the requirement is quite small. They also indicate the likelihood that at time of hatching the chick is supplied with a sufficient quantity of essential fatty acids through its body reserves and the unabsorbed egg yolk to meet its needs through the first few weeks of life.

Russell *et al* (1940) found that the reduction of substances in a practical chick diet, soluble in diethyl ether, to 0.1% or less did not retard the growth of chicks significantly up to 14 wk of age, when provision was made for the vitamins removed by the extraction process. Reiser (1950) presented evidence which suggested that the chick is unable to synthesize linoleic and linolenic acid. The quantity of these fatty acids in the bodies of 4 wk old chicks given a fat-free diet appeared to be no greater than the amount present in the eggs of hens fed either a stock diet or a purified fat-free diet. Bieri *et al* (1956) reported that the chick requires highly unsaturated

* Reproduced from the 14th Distillers Feed Conference, 1232 Enquirer Bldg., Cincinnati 2, Ohio

fat in the diet in order to grow normally. Chicks fed a diet containing no corn oil grew poorly after 6 to 8 wk of age. Depigmentation of feathers occurred from about the eighth week and scaliness of skin was observed in several chicks after 16 to 20 wk of age.

EXPERIMENTS WITH INEDIBILE FATS

Rosenberg and Baldini, Sunde and Bird and Runnels (1955) in a collaborative study observed improved growth in chicks as well as improved feed conversion by adding 3 to 5% fat to diets of practical character containing approximately 2.5 to 3% fat. Rosenberg and Baldini used corn oil and prime tallow in their work, Sunde and Bird white grease and Runnels yellow grease. Donaldson *et al* (1957) reported that the addition of 10% stabilized yellow animal grease to practical chick diets containing from 3.8 to 4.6% fat promoted increased growth. Vondell and Ringrose (1958) obtained significant increase in growth in chicks fed a practical diet containing 15.7% added tallow over that of chicks fed a similar diet containing 2% added fat which had the same energy-protein ratio. The difference in favor of the larger quantity of fat tended to disappear, however, when oat hulls were added to the rations in increasing amounts in order to give narrower energy-protein ratios. Waibel (1958) found that stabilized animal fat composed of approximately equal portions of beef and hog fat (Titer, 41° C), promoted increased growth in turkey poults given a practical diet which contained about 2.75% fat before adjustment for fat supplementation.

In contrast Baldini and Rosenberg (1957) reported that prime tallow added to a practical diet did not stimulate growth in chicks when the protein and energy contents of the diets were maintained constant by substituting fat and cellulose for Cerelose. They attributed the effect of adding fat to the chick diet to be due entirely to the caloric value of the fat. Increasing the fat content of the diet without increasing caloric content was also observed to have no effect on the amount of feed per unit gain, but the fat content of the chick bodies was increased by 12.6%. The results of Baldini and Rosenberg are open to question, however, since they failed to consider the possibility that the added cellulose interfered with feed consumption and thus offset the growth stimulating effect of the tallow used in their work.

EXPERIMENTS WITH EDIBLE FATS

Carver and Johnson (1953) reported that chicks fed a

purified casein diet or a purified soybean protein diet containing respectively 0.05 and 0.04% fat as determined by hexane extraction require factors present in unsaturated fat for maximum growth. Crude corn oil, refined corn oil, soybean oil, wheat germ oil, an oleic acid concentrate and a linolenic acid concentrate were found to contain these factors in varying concentrations. Wheat germ oil and the oleic acid concentrate were superior to the other products in stimulating growth. Yacowitz (1953) obtained evidence that chicks fed a diet composed largely of corn meal and solvent process soybean oil meal and containing 2.49% ether-extracable substances grew at a somewhat faster rate and had better feed conversion when the diet was supplemented with 2.5 and 5% cottonseed oil, soybean oil or lard. Donaldson *et al* (1957) found that corn oil stimulated growth of chicks fed a purified diet containing 2% corn oil and a simplified diet containing some ingredients of a practical character which provided 2% fat.

Arscott *et al* (1957) showed that the fat fraction of dried egg yolk significantly stimulated growth of chicks fed a diet composed largely of soybean oil meal and sucrose. The diet probably contained approximately 0.5% fat. Menge *et al* (1957) presented evidence of the existence of a chick growth factor in the substances removed from dried egg yolk by common fat solvents. The factor was shown not to be identical with oleic acid, linoleic acid or lecithin. It was present in the non-phospholipid and non-saponifiable portion of the yolk extract. The factor was destroyed by ultraviolet irradiation and by hot, but not by cold, saponification. Scott *et al* (1958) found that both egg oil and corn oil promote chick growth to approximately the same extent when fed on an isocaloric basis in isonitrogenous diets.

CORNELL UNIVERSITY EXPERIMENTS WITH VARIOUS FATS

In work conducted at Cornell University by Dam *et al* (1959) dealing in part with the development of high energy diets for use in studies of unidentified chick growth factors, results have also been obtained which show that fats of vegetable origin stimulate chick growth. A purified diet containing 5% corn oil (table I) and similar diets containing 10 and 20% corn oil were used in most of the experiments. These diets contained 325, 350 and 400 Cal of metabolizable energy per 100 gm respectively. In 2 experiments practical diets containing 3.4 and 2.8% of ether-extractable substances (diets A and B, table IV) were used. These diets were supplemented with

TABLE I

COMPOSITION OF PURIFIED BASAL DIETS

Ingredient	Cornell[1]	Illinois[2]
	gm/100 gm	
Glucose (Cerelose)	53.34	52.61
Soybean protein (Drackett)	31.05	35.30
Cellulose (Solka-Floc)	3.00	5.00
Corn oil	5.00	0.50
DL-Methionine	0.70	0.75
Glycine	0.30	0.30
Choline chloride	0.15	0.20
Mineral mixture	5.43	5.34
Vitamin mixture	1.01[3]	0.0627[4]
Butylated hydroxy toluene (BHT)	0.022	.....
Diphenyl-p-phenyldiamine (DPPD)	.....	0.0011
Procaine penicillin	.....	0.0062

[1] Dam *et al*, J. Nutr. (in press), 1959.
[2] Rand *et al*, Poultry Sci. 37:1075, 1958.
[3] Vitamins and vitamin A, D and E diluents plus glucose to 1.01 gm.
[4] Vitamins only.

7.5 and 8.6% soybean oil, respectively. The unsupplemented and supplemented diets contained respectively 300 and 335 Cal of metabolizable energy per 100 gm.

Increasing the quantity of corn oil in the purified diet from 5 to 10% was found to increase chick growth significantly ($P < 0.01$) in repeated experiments (table III). No further growth increase was obtained by including 20% corn oil in the basal diet. The gain per unit of feed consumed, however, was improved with each increase in fat content. The growth increase was obtained either with or without the inclusion of a mixture of crude sources of unidentified growth factors (UGF) in the purified diet. In one experiment, some evidence of an interaction between the unidentified factors and corn oil was obtained. In work with the practical diets the inclusion of 7.5 or 8.6% soybean oil in them also significantly increased the growth rate ($P < 0.01$).

The UGF mixture added to the purified diets was composed of 2 parts corn Distillers Dried Solubles, 1 part dried whey product and 1 part fish solubles. The moisture content of the mixture was reduced to 8.85% after which 10% of the dried material was added to the diets in such a way as to maintain the protein-energy ratios constant.

In further work on the growth stimulating properties of fats, a purified diet and a diet with sources of UGF, each containing 10% corn oil, were used as standards. When diets containing 10% peanut oil, cottonseed oil or soybean oil were compared with the diets containing 10% corn oil, no growth

differences were observed, regardless of type of diet fed the chicks. This indicated that all these oils were equally growth stimulating. The growth obtained with 10% hydrogenated vegetable oil, however, was significantly less ($P<0.01$) than that obtained with the non-hydrogenated vegetable oils, and that obtained with lard in the basal plus UGF half of the experiment was intermediate. According to Duncan's multiple range test, the growth depression obtained with lard was also statistically significant ($P<0.05$).

POSSIBLE EXPLANATIONS OF THE GROWTH-PROMOTING PROPERTIES OF FATS

The improved growth obtained in the Cornell University investigation by increasing the quantity of non-hydrogenated vegetable oil in the chick diet from 5 to 10% was not due to the lack of capacity of the chicks to eat more feed. Chicks fed the practical diet (table II) containing 3.4% fat reached only

TABLE II

COMPOSITION OF PRACTICAL BASAL DIETS[1]

Ingredients	Diet A	Diet B
	gm/100 gm	
Yellow corn meal	58.80	58.45
Soybean oil meal, 50%	26.25	.....
Soybean oil meal, 44%	.....	26.85
Corn gluten meal	2.50	2.50
Fish meal	2.50	2.50
Corn Distillers Dried Solubles	2.00	2.00
Dried whey product	2.00	2.00
Alfalfa meal, 17%	2.50	2.50
Dicalcium phosphate	1.50	1.50
Pulverized limestone	1.60	1.35
Salt, iodized	0.25	0.25
Manganese sulfate	0.02	0.02
DL-Methionine	0.038	0.038
Vitamin D_3 (3000 I.C.U./gm)	0.013	0.013
Vitamin, antibiotic and antioxidant supplement	0.03	0.03

[1] Cornell Univ. Agr. Expt. Sta.

slightly greater weight at 4 wk of age than the chicks fed the Cornell purified diet (table I) containing 5% corn oil and sources of unidentified factors (504 vs 482 gm), yet they consumed approximately 200 gm more feed per chick (870 vs 669 gm). The greater quantity of feed consumed by chicks fed practical diets in attaining growth rates comparable to those of chicks fed more concentrated purified diets has been frequently observed at this laboratory.

The results suggested that the improved growth of the chicks provided 10% corn oil as compared with 5% oil (table

III) was due to a more optimum concentration of energy unrelated to the capacity of the chick to consume feed. Absolute energy level, however, was not the determining factor, since the quantity of energy per gram of feed in the practical ration containing 7.5% soybean oil (table IV) was less than the concentration of energy per gram of feed in the supplemented purified diet containing 10% corn oil (3.35 vs 3.50 Cal metabolizable energy per gm), although growth of the chicks was almost identical (536 vs 531 gm).

The increased growth also suggested the possibility that the lower specific dynamic action of fat in comparison with carbohydrates reduced the heat loss and thus produced a saving in energy which was used in bringing about greater gains in weight. The efficiency of energy utilization, however, was not improved in this work by increasing dietary fat as measured by gain in weight, but appeared to be increased by supplementation with unidentified factors. This is made evident by calculating grams gained per 100 Cal of metabolizable

TABLE III

EFFECT OF FAT LEVEL ON GROWTH OF CHICKS FED BASAL AND SUPPLEMENTED DIETS[1]

Treatment	Experiment	Av 4 wk wt	Feed/gm gain
		gm	gm
Basal Diet			
5% Corn oil	1, 2	404(66)[2]	1.60
10% Corn oil	1, 2, 3	438(95)	1.44
20% Corn oil	1, 3	458(67)	1.30
Basal Diet Plus UGF[3]			
5% Corn oil	1, 2	482(67)	1.50
10% Corn oil	1, 2, 3	531(98)	1.38
20% Corn oil	1, 3	522(69)	1.24

[1] Dam *et al*, J. Nutr. (in press), 1959.
[2] Number survivors.
[3] Unidentified growth factor supplements.

energy. These values for the lots of chicks fed the basal diet containing 5, 10 and 20% fat were 19.4, 19.7 and 19.3 gm, respectively, and for the UGF supplemented diet 20.5, 20.8 and 20.5 gm, respectively.

The increased caloric efficiency of the supplemented diets, since they promoted more rapid growth, may have been caused by a greater utilization of metabolizable energy for gain in weight relative to maintenance than occurred when the basal diets were fed. The greater caloric efficiency of the supple-

TABLE IV

EFFECT ON CHICK GROWTH OF SUPPLEMENTING PRACTICAL BASAL DIETS WITH SOYBEAN OIL

Treatment	Fat content of diets	Av 8 wk wt	Feed/gm gain
	%	gm	gm
Experiment 1			
Basal diet A	3.4	1462(38)[2]	2.28
+ 7.5% Soybean oil	10.1	1609(40)	1.97
+ Cooked, ground soybeans	9.9	1435(19)[3]	2.03
Experiment 2			
Basal diet B	2.8	1498(35)	2.39
+ 8.6% Soybean oil	10.2	1647(40)	2.03
+ Cooked, ground soybeans	10.3	1472(36)	2.15

[1] Dam *et al*, J. Nutr. (in press), 1959, and unpublished results Cornell Univ. Agr. Expt. Sta.
[2] Survivors of duplicate lots of 20 WPR male chicks each at start.
[3] One lot after 6 wk.

mented diets may also have been caused by the fact that these diets were more nutritionally complete than the basal diets. Consequently, a better utilization of metabolizable energy was obtained through reduction of heat losses.

The growth promoting effect of non-hydrogenated vegetable fats observed in the Cornell University experiments, therefore, may be due to the presence of an unidentified factor in them, presumably in the non-saponifiable fraction, in view of the results of Menge *et al* (1957). The factor is probably destroyed during the process of hydrogenation, since it does not appear to be present in hydrogenated vegetable fat. The growth promoting effect may also be caused by previously unrecognized characteristics of the known components of unsaturated fats. If this is true, the quantity required is quite large, since between 5 and 10% of corn oil is required for maximum growth.

UNIVERSITY OF ILLINOIS EXPERIMENTS WITH CORN OIL

Following the completion of the experiments conducted at Cornell University, Rand *et al* (1958) of the University of Illinois presented additional evidence of the growth promoting properties of corn oil. Purified diets containing either 0.5 or 1% corn oil (table I) were used in the investigation. On paired feeding isocaloric diets, the inclusion of 7.5 to 8% or more of corn oil in them was found to promote significant growth increases. In an experiment in which non-isocaloric diets were fed, significant growth increases (table V) were

obtained with 8.3% corn oil, both with *ad libitum* feeding and with equalized calorie feeding, but no further increase was ob-

TABLE V

EFFECT OF FAT LEVEL ON CHICK GROWTH IN *AD LIBITUM* AND EQUALIZED CALORIE FEEDING[1]

Treatment[2]	Calories/chick	Av 4 wk wt	Feed/gm gain
		gm	gm
Ad Libitum Feeding			
0.5% Corn oil	2,020	398	1.84
8.3% Corn oil	2,080	439	1.52
18.1% Corn oil	2,130	436	1.39
30.7% Corn oil	2,230	453	1.22
Equalized Calorie Feeding			
0.5% Corn oil	2,120	405	1.90
8.3% Corn oil	2,120	449	1.50
18.1% Corn Oil	2,120	440	1.37
30.7% Corn oil	2,120	434	1.22

[1] Rand *et al*, Poultry Sci. 37:1075, 1958.
[2] All chicks fed purified basal diet first 7 days. Each treatment included 3 lots of 10 chicks each, selected at end of 7 days to insure equal average weight.

served either with 18.1 or 30.75% fat. Rand *et al* assumed that 0.5% corn oil is sufficient to meet the chick's need for essential fatty acids and concluded, therefore, that the effects observed in their work were not caused by a deficiency of these substances. Since previous experimental work supports this assumption, the results reported by these investigators and those obtained at Cornell University appear to be in close agreement.

In the investigation conducted by Rand *et al* (1958) the grams gain per 100 Cal was increased by raising the fat content of the basal diet from 0.5 to 8.3% but no further increase was obtained by raising the fat content to higher levels. This disagreement with the findings of Dam *et al* (1959) was presumably due to the fact that the purified basal diet used by Rand *et al* was more deficient in the growth stimulating properties of corn oil than the purified basal diet used in the Cornell University investigation.

The work of Rand *et al* (1958) rules out the possibility that the improved growth obtained with corn oil is related to the feed capacity of the chick or the increased energy content of the diets since by restricting the caloric intake of all lots of chicks to that of the chicks fed the basal diet the growth increase observed in *ad libitum* feeding was still obtained. On

the other hand, the results of these workers, in contrast to those of Dam *et al* (1959), do not rule out the possibility that the growth increase was due to the lower specific dynamic action of fat.

EFFECT OF CORN OIL AND VARIOUS ANIMAL FATS ON EGG WEIGHT

Jensen *et al* (1958) of Washington State College presented evidence that an unidentified factor present in yellow corn and several other feed ingredients is necessary for maximum egg weight, egg production and hatchability of fertile eggs. On feeding graded quantities of corn, 70% was found to be more effective than smaller quantities. Crude corn oil, fed at a

TABLE VI

EFFECT OF CORN OIL ON EGG WEIGHT[1]

Treatment	Av Egg Wt		% of pre-experimental
	Pre-experimental	Experimental	
First Experiment	gm	gm	
Basal	56.8[2]	54.7	96.3
+ 3% Corn oil	57.6[2]	57.6	100.0[4]
+ 3% Tallow	58.3[2]	55.1	94.6
Confirmatory Experiment			
Basal	55.3[3]	55.9	101.0
+3% Corn oil	54.9[3]	57.6	104.9[5]
+3% Tallow	55.5[3]	56.8	102.2

[1] Jensen *et al*, J. Nutr. *65*:219, 1958.
[2] Last 2 wk of pre-experimental period, when hens were fed stock diet.
[3] Last 2 wk of pre-experimental period, when hens were fed basal diet.
[4] Significantly different from basal diet ($P<0.01$).
[5] Significantly different from basal diet ($P<0.05$).

level of 3%, was as effective as 70% corn in raising egg weight but 3% of tallow was ineffective. In work by Schutze *et al* (1958) in which graded levels of corn oil were fed, the greatest effect on egg weight was obtained with 5% corn oil. A comparison of the value of tallow, egg yolk fat and butter fat with corn oil showed that only corn oil markedly increased egg weight. Whether or not the egg weight factor of corn oil and its growth stimulating properties are identical is unknown at present.

EVIDENCE FOR GROWTH-STIMULATING PROPERTIES IN ANIMAL FATS IS CONFLICTING

The evidence for the existence of a factor or properties in lard and inedible animal fats which stimulate chick growth

is conflicting. The results of the work conducted by Dam *et al* (1959) indicate the lard is at times at least less effective in stimulating chick growth than vegetable fats. Menge *et al* (1957) found that 5% stabilized lard failed to stimulate chick growth in an experiment in which lard was compared with egg yolk fat. In contrast, Denton *et al* (1954) reported that chicks fed a practical diet grew faster when lard was added to the diet. Baldini and Rosenberg (1957) concluded that the effect of prime tallow on chick growth is due entirely to caloric content. On the other hand, other workers have reported that the inclusion of prime tallow, white grease and yellow grease in chick diets significantly stimulated chick growth.

EFFECT OF SOYBEAN OIL ON FEED COST PER POUND OF GAIN

The effect of soybean oil on the cost of feed per pound of gain was calculated from the data presented in table V and the wholesale price per ton at Buffalo, New York, on February 18, 1959, of the ingredients used in the practical diets. The wholesale price of soybean oil at that time was $201.50 per ton. After calculating the wholesale cost of the quantities of ingredients used per ton in the practical diets, these values were increased by $30.00 per ton to cover overhead and manufacturing, sales, shipping and local distribution costs. Feed cost per pound of gain was calculated by multiplying the pounds feed consumed per pound of gain by the cost of feed per pound. The results of these calculations (table VII) show that under the conditions of the experiments the lowest

TABLE VII

FEED COST PER POUND OF GAIN IN CORNELL UNIVERSITY EXPERIMENTS WITH PRACTICAL DIETS

Treatment	Broiler wt	Age at equal wt	Feed per lb gain	Feed cost per ton[1]	Feed cost per lb gain
	lb	days	lb	$	c
		Experiment 1			
Basal diet A	3.54	60	2.34	90.50	10.58
+ 7.5% Soybean oil	3.54	56	1.97	104.15	10.26
		Experiment 2			
Basal diet B	3.63	60	2.44	90.35	11.02
+ 8.6% Soybean oil	3.63	56	2.03	105.50	10.70

[1] Based on wholesale prices at Buffalo, N. Y., February 18, 1959, plus $30.00 per ton mark-up.

feed cost per pound of gain was obtained by feeding the practical diets supplemented with soybean oil. Furthermore, the chicks fed the supplemental diets reached market weight 4 days sooner than those fed the practical diets without added fat. The quantity of soybean oil needed to promote maximum response has not yet been determined at Cornell University, but experimental work on this aspect of the problem is in progress. After this work is completed studies will be made of the relative growth stimulating properties of soybean oil and the inedible fats now customarily used in practical chick diets.

The improved chick growth obtained by Dam *et al* (1959) with vegetable oils suggested the possibility that cooked soybeans might supply soybean oil more cheaply than the extracted product. The results of 2 experiments using duplicate lots of chicks per treatment are presented in table IV. They showed that the cooked soybeans failed to stimulate chick growth. The amount of feed required per pound of gain, however, was decreased in both experiments. The cause of the failure to obtain increased growth with cooked soybeans is not clear. The soybeans used in experiment 1 were autoclaved for 15 min at 15 lb pressure by the Western Condensing Company, Appleton, Wisconsin. Approximately 15 min were required to bring the beans up to the specified pressure and 15 min to cool them after release of pressure. The beans used in experiment 2 were autoclaved for 12 min at 15 lb pressure in the nutrition laboratories of the Cornell University Poultry Husbandry Department. About 5 min were required to bring the beans up to the specified pressure and 2 min to release the pressure.

SUMMARY

In experiments conducted with chicks at Cornell University, highly significant growth increases were obtained by increasing the vegetable fat content of purified diets from 5 to 10% and practical diets from about 3 to approximately 10%. No further growth increase was obtained by raising the vegetable fat content of purified diets to 20%. The responses were obtained with purified diets supplemented with sources of unidentified growth factors and with basal purified diets. The growth of chicks fed hydrogenated vegetable fat was significantly less than that of chicks fed an equal quantity of

non-hydrogenated vegetable fat, indicating that the growth-promoting effect was markedly reduced during hydrogenation.

Significant growth increases in chicks fed purified diets have also been obtained with corn oil at the University of Illinois and significant increases in egg weight have been observed at Washington State College.

The evidence indicates that the improved growth is not due to a lack of capacity of the chicks to eat more feed, or to a more optimum concentration of energy unrelated to food capacity. The evidence also indicates that the response is not due to the lower specific dynamic action of fat making more energy available for growth. The effect, therefore, appears to be caused either by an unknown substance in vegetable fats or by heretofore unrecognized characteristics of the known components of fat.

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ANNUAL MEETING OF THE UNITED KINGDOM BRANCH OF THE WORLD'S POULTRY SCIENCE ASSOCIATION

The Annual General Meeting of the United Kingdom Branch of the Association was held at the Royal Veterinary College, London, on 10th April. It was reported that at 31st December, 1958, there were 475 fully paid members and that of these 395 were in England, 46 in Scotland, 23 in Northern Ireland, and 11 in Wales. It was also reported that two conferences had been held in 1958, one on the occasion of the Annual General Meeting, and the other on the occasion of the National Poultry Show, Olympia, London.

The Annual General Meeting was followed by a Conference at which the following papers were presented by members of the Branch. Each author was limited to 10 minutes, followed by 10 minutes for discussion on his subject. The papers evoked lively discussions. There was an attendance of 125.

"Windowless Battery Laying Cage House" (Mr. H. Glasser, Paddock Cottage Poultry Farm, Wilstone, Tring, Herts.)

"Some aspects on insulating Poultry Houses" (Mr. P. Matthews, B.O.C.M. Demonstration Farm, Stoke Mandeville, Bucks.)

"Observations on mixed parasite infestations acquired by chickens reared on old built-up litter" (Mr. P. L. Long, A.I.M.L.T., Houghton Poultry Research Station, Houghton, Huntington.)

"Methionine Supplementation of Broiler Diets at Varying Protein Levels" Mr. D. G. A. Guttridge, M. Sc., N.D.P. and Dr. J. T. Morgan, Ph.D., M. Sc., A.R.I.C., The University of Nottingham, Nottingham.)

"Integration in Poultry Production" (Mr. Geoffrey Sykes, The Sykes Broiler Service Ltd., Godwins, Berwick St. James, Salisbury, Wilts.)

"Restricted Feeding Times for the Laying Bird" (Mr. J. A. Cherry, University of Reading, Reading, Berks.)

"Observations on the use of Ultra Violet light as a Method of Determining Freshness in Refrigerated Eviscerated Broilers" (Dr. D. H. Shrimpton, B.A. (Cantab), Ph. D., and Mr. B. J. H. Stevens, Low Temperature Research Station, Downing Street, Cambridge.)

"Comparison of Pullets Housed Singly and in Pairs in Laying Cages" (Mr. T. R. Morris, B. Sc., Dip. Agr. and Mr. R. C. Jennings, University of Reading, Reading, Berks.)

"The Hatchability of Eggs from Birds Fed Different Protein Supplements", (Mr. S. Fox and Miss R. S. Martin, University of Reading, Reading, Berks.)

U. S. A. POULTRY AND POULTRY PRODUCT EXPORTS UP ABOUT 9 PERCENT IN 1958

The estimated value of all U. S. poultry and poultry product exports in 1958 amounted to $37.8 million, compared with $34.7 million in 1957. This was a gain of almost 9 percent. Poultry meat exports valued at $17 million exceeded, for the first time, the value of eggs and egg products, which amounted to $16.1 million. Live poultry, including baby chicks, accounted for the remaining $4.7 million.

Exports of fresh or frozen chickens and capons amounted to 37.0 million pounds, compared with approximately 28.5 million pounds in 1957. An increase in exports to Switzerland and Canada brought about the greater part of the rise. Exports of other poultry and game, including turkeys, were 2 percent above a year earlier in quantity but 5 percent lower in value due to a lower average price.

Only 37 percent of the latter went to Canada compared with 68 percent a year ago, and 75 percent in 1956 when the embargo on turkeys first went into effect. However, Canada's imports of U. S. chickens and capons—mostly broilers and fryers—were up 42 percent, bringing total Canadian imports of all poultry meat almost to the 1957 figure. Although exports of chickens and capons to Germany decreased moderately, this was offset by a sharp increase in shipments of turkeys. U. S. canned poultry exports amounted to over 2.9 million pounds in 1958 compared with less than 2.2 million in 1957, with exports to West Germany accounting for most of the increase.

Exports of shell eggs during 1958 were only 28.9 million dozen as against 31.7 million dozen in 1957—down 9 percent—but the value of shell egg exports was up 7 percent. This probably was due to a larger proportion of hatching eggs exported in 1958. Hatching eggs, shown separately for the first time in 1958, averaged 99 cents a dozen, probably accounted for most of the increase in the average value of all eggs which was 52 cents compared with 45 cents in 1957.

Venezuela remained in first place as a market for U. S. shell eggs although reducing its imports by 26 percent. Spain was an important outlet in 1958, taking almost 5 million dozen, nearly all of which were programed under Section 402 of the Mutual Security Act. U. S. exports of dry egg solids were about one-half of those in 1957 both in volume and value, the

average price remaining approximately the same. Shipments of frozen and other preserved eggs were equal to only 75 percent of those in 1957.

Total shipments of U. S. live poultry were down a little in 1958 from 1957 but the value was slightly higher because of higher average export prices. Mexico, Cuba and Venezuela decreased their imports of baby chicks but Canada and the Caribbean Islands other than Cuba increased their imports substantially in 1958. Mexico continued to take most of U. S. exports of live poultry other than baby chicks—about 4 million pounds. Canada imported about one-half million pounds of this type poultry in 1958 and remained the only other U. S. market of significance.

(Foreign Agriculture Circular,
U. S. Dept. of Agriculture)

TWELFTH CONGRESS IN SYDNEY, AUSTRALIA

August 13-18, 1962

The Honorable Minister for Primary Production, Mr. C. F. Adermann, has announced that the 12th World's Poultry Congress will be held at New South Wales Royal Agricultural Society's Showgrounds in Sydney, Australia, from August 13th to 18th, 1962.

REVIEW OF POULTRY PUBLICATIONS

Compiled by J. W. Kinghorne

1365 Iris St., N.W.

Washington 12, D.C., U.S.A.

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GENETICS

AUXILIA, M. T., GORIA FAZIO, M. G., and **TRINCHIERI, P.** 1958 [Ist. Radiol., Univ. Turin.] Ricerche intorno agli effetti delle radiazioni Roentgen e degli ultrasuoni sui testicoli di gallo in confronto agli stilbenici.

A COMPARATIVE STUDY OF THE EFFECTS OF X-RAYS, ULTRASONICS AND STILBENES ON THE TESTES OF THE COCK. *Ann. Sper. agr.*, N.S., *12:* 889-903. [English summary.]—Spermatogenesis was inhibited, but caponisation was not induced, in White Leghorn cockerels subjected to ultrasonics (5 doses of 3-10 watts for 10 mins. on each testis) or to X-rays (3 doses of 300-1000 r on each testis), although reduction in size of comb and testes occurred in some of the birds. Caponisation was induced in birds injected subcutaneously with 10 mg. of a stilbene preparation. Six mths. after treatment, 1 cockerel from each group, namely ultrasonic, X-ray and hormone, was mated with 10 hens, 50 eggs being set for each group. Hatching percentages were 72, 0 and 84 resp. (Animal Breeding Abstracts)

BAKER, R. C. 1958 [Purdue Univ., Lafayette, Ind.]

CHALAZAE OF THE DOMESTIC FOWL—LYSOZYME CONTENT AND FACTORS AFFECTING THEIR PROMINENCE. *Diss. Abstr., 18:* 12.—The lysozyme content of the chalazae was higher in some strains than in others. Prominence of the chalazae was found to be a heritable character not correlated with the internal quality of the egg. It would thus be possible, by means of selection, to decrease the prominence of the chalazae without affecting egg quality. (Animal Breeding Abstracts)

BARRAUD, C. 1958. [Ec. Nat. Vet., Alfort.] A propos d'un cas d'hybridation entre le dindon et la pintade.

ON A CASE OF HYBRIDISATION BETWEEN THE TURKEY AND THE GUINEA-FOWL. *Thèse Doct. Vét., Fac. Méd., Paris,* 59 pp.—The morphological and other external characters of a reputed hybrid between a ♂ turkey *(Meleagris gallopavo)* and a guinea-hen *(Numida meleagris)* are described and compared with those of the supposed parents. The bird was hatched in Morocco in 1951, and when described at 3 yrs. of age was intermediate between the parents in size. Its sex could not be determined on the basis of the external

characters. It showed no sexual behaviour, however, and was apparently sterile. Reference is made to reports of other interspecific hybrids involving the turkey or the guinea-fowl. (Animal Breeding Abstracts)

CARNE, H. R., and **WATERHOUSE, W. L.** 1958. [Dep. Vet. Path. Bact., Univ. Sydney.]

SEX-REVERSAL AND ABNORMAL SEX RATIOS IN THE DOMESTIC FOWL. *J. Hered., 49:* 102, 106.—A case of sex reversal in a Black Orpington pullet is recorded. The bird appeared "off colour" when about 12 mths. old but subsequently recovered and began to develop ♂ plumage. At 13-14 mths. from hatching the ♂ characters were clearly marked. About a month later the bird began to behave as a ♂. When mated with Black Orpington and Australorp pullets it produced exclusively ♂ chicks. Egg fertility was low and many embryos died in shell. A post mortem examination revealed a pair of normal, well-developed testes and no sign of ovarian or other ♀ tissues. The right kidney was absent. An attempt is made to formulate a hypothesis that might explain the phenomenon. (Animal Breeding Abstracts)

CHAMPION, L. R. 1958. [Dep. Poult. Husb., Michigan State Univ. Agric. Exp. Sta., East Lansing.]

THE INHERITANCE OF IMPERFECT ALBINISM IN THE FOWL. *Quart. Bull. Mich. agric. exp. Sta., 41*: 237-245.—An albinotic condition, apparently due to a mutation, was exhibited in 6 chicks of a non-pedigreed supply flock of S.C. White Leghorns. Characteristics of the condition were light sensitivity and short down. Carotenoid pigments were present in the skin, beak and shanks. Four pullets survived to maturity, and test matings were made, as a result of which it is suggested that the condition arose as an independent mutation, but that it seems to be identical to the simple sex-linked recessive imperfect albinism described by Mueller and Hutt in 1941. Histological examination of the eyes of normal and affected chicks revealed a subnormal amount of melanin in the latter. The condition did not appear to be associated with hatchability, which was uniformly high in all stocks. Nor was there any differential embryonic mortality. Brooding mortality was comparable in normals and albinos, as was adult viability. Egg yield of F_1 albinos was similar to that of the other S.C. W.L. stocks. (Animal Breeding Abstracts)

COOPER, D. M. 1958. [Inst. Poult. Res., Houghton, Huntingdon, England.]

Over enige problemen, die zich bij het fokken van kalkoenen voordoen, in het bijzonder met betrekking tot de toepassing van kunstmatige inseminatie.

ON SOME TURKEY BREEDING PROBLEMS, WITH PARTICULAR REFERENCE TO THE USE OF ARTIFICIAL INSEMINATION. *Tijdschr. Diergeneesk., 83:* 944-952. [English, French and German summaries.]—The increase in egg fertility that can be brought about by means of A. I. varies with different birds, but may be considerable. Artificial insemination can be used either alone or in combination with natural mating. In the latter case, the toms are removed from the hens for a few days at the beginning of the breeding season, although remaining within sight. The hens are inseminated immediately after the collection of the semen, and the toms are then allowed to mate naturally. Further insemination may be made when the percentage of egg fertility falls, as it does towards the end of the season. The method of insemination is briefly described. Semen cannot be kept for more than an hour at the beginning of the season, or half an hour at the end of the season, without loss in fertility. No suitable diluent for turkey semen has so far been discovered. When A.I. is used exclusively, the semen, should be collected 3 times a week, on alternate days. The av. volume of the ejaculate is 0.2 $cm.^3$ In general, the ♀ ♀ should be inseminated with 0.03 $cm.^3$ of undiluted semen every 3 wks., but fortnightly inseminations are necessary towards the end of the breeding season. A practical

scheme for eliminating broodiness is described. (Animal Breeding Abstracts)

De MUELENAERE, H. J. H., and **G. V. QUICKE.** 1958. [Agric. Res. Inst., Pietermaritzburg.]
STUDIES ON THE BIOCHEMISTRY OF COCK SEMEN. 2. THE PROBLEM OF BACTERIAL CONTAMINATION. *S. Afr. J. agric. Sci., 1:* 139-149. [Afrikaans and French summaries.]—Bacterial counts on 25 samples of cock semen immediately after ejaculation averaged 55 million per ml. (2 million-170 million), which is very much higher than in bull semen. The increase in bacterial counts during storage at 37°C. up to 24 hrs. was considerably faster in washed than in whole semen. Hyamine 1622 at a concentration of 0.067 prevented the development of bacteria in the semen but had a deleterious effect on the sperm. Three suspensions containing 100,000 units penicillin, 300 mg. sulphanilamide, and 300 mg. sulphapyridine resp., and one containing a 1:1:1 mixture of all 3 solutions, were tested for motility after storage up to 84 hrs. at 4° C., room t.° and 37° C. Penicillin had a marked deleterious effect on motility, while only sulphanilamide appeared to have a slightly beneficial effect. Data on glucose utilisation in the semen are included. (Animal Breeding Abstracts)

DEVARAJ, R. M. 1958
OBSERVATIONS ON LOCAL (MALAYAN) TROPICAL FOWLS. STUDY III—A COMPARISON OF LAYING PATTERNS. *Malay. vet. med. Ass., 2:* 9-19.—From actual observations the laying characters of local Canton-type birds are compared with those of ordinary European breeds as reported in the literature. As regards number of eggs in the pullet year, percentage lay and weight of egg, the estimated performance of the former (under optimal conditions) is 150-160, 40-45% and 1.4 oz. (1.0-1.9) *v.* 170, slightly over 50% and 2 oz. (0.9-2.15) for the latter. Age at 1st egg is about 180 days (137-305) in European light breeds and 165 days (136-222) in local Canton-type birds. Approximately 72 clutches per laying yr., mostly of 2 eggs each, and 58 short pauses per yr., averaging 1.1 days in length, are given for European birds *v.* 67 clutches, 2.1 eggs, 54 pauses and 1.9 days for local birds.
Broodiness is estimated to occur in 5% of potentially broody European birds approx. twice a year, whereas all the local birds go broody approx. 10 times per yr. (4-17). There is no definite moulting season in Singapore, where it is a more or less continuous process. Because there is thus no specific pause in laying, and as there is no winter pause, persistency (time between 1st and last egg in yr.) is greater for local (av. 363 days) than for European birds (av. 294 days). (Animal Breeding Abstracts)

DUBOVSKII, N. V., and **V. N. KOPYLOV.** 1958 [Ukrainian Poult. Breed. Exp. Sta.] Mezlineinaja gibridizacija — perspektivnyi putj povysenija produktivnosti kur.
INTER-LINE CROSSING—A PROMISING METHOD OF INCREASING THE PRODUCTION OF THE DOMESTIC FOWL. *Pticevodstvo, 8(10):* 27-32.—In 1956 comparative trials were carried out at the Experimental Station with 2 groups of line-crosses and 1 group each of Russian Whites and New Hampshires. The line-crossed eggs were imported from U.S.A. and were obtained by crossing single lines of New Hampshires×Rhode Island Reds with 2 crossed lines of White Leghorns, and by crossing 4 lines of White Leghorns. Hatchability, survival percentage, egg production, and total weight of eggs produced were greater for the line-crosses than for the Russian Whites and New Hampshires. Points from an argument of H. F. Kusner against the crossing of inbred lines are summarised and points in favour of line-crossing are presented. (Animal Breeding Abstracts)

ERASMUS, J. E. and **C. R. LIEBENBERG.** 1958. [Stellenbosch-Elsenburg Coll. Agric., Stellenbosch.] 'n Nuwe mutant by die verekleur

van die Suid-Afrikaanse Swart Australorp.

A NEW MUTATION IN THE PLUMAGE COLOUR OF THE SOUTH AFRICAN BLACK AUSTRALORP. *S. Afr. J. agric. Sci., 1:* 227-230.—The appearance of grey plumage colour was reported in a flock of purebred Black Australorps. The results of test matings indicated that the mutation is due to a single autosomal recessive gene. The colour is described as a light to dark brownish grey, which bleaches to a dirty yellow in old birds; one bird showed depigmentation. (Animal Breeding Abstracts)

ESKILT, V. A., N. VIKE, B. UKKELBERG, and **I. UNDHEIM.** 1958. Forsok med brukskryssing av honer.

EXPERIMENTS ON THE COMMERCIAL CROSSING OF FOWLS. *Tidsskr. norske Landbr., 65:* 160-185. [English summary.]—The performance during 1951-57 of Jaer, White Leghorn, Brown Leghorn, Legbar and Plymouth Rock pure- and crossbred hens was compared from 11 to 530 birds representing each breed or crossbred group in each laying year. In the crossbreds age at 1st egg varied from 153 days in the Legbar ♂ × Jaer ♀ to 183 days in the Brown Leghorn ♂ × Plymouth Rock ♀; [adult?] live weight varied from 1.76 kg in the Jaer ♂ × White Leghorn ♀ to 2.25 kg. in the White Leghorn ♂ × Plymouth Rock ♀. Mortality rate and percentage broodiness are tabulated for each breed and crossbred group in each laying year. Amongst the Jaer crossbreds, weight of eggs laid and hatching percentage during 950 days varied from 27.14 kg. and 50.1% in the Legbar ♂ × Jaer ♀ to 29.91 kg. and 55.2% in the Jaer ♂ × Plymouth Rock ♀. Weight of eggs laid by Jaer crossbreds during their 1st laying year was from 3% (in the Jaer ♂ × White Leghorn ♀) to 42% (in the Legbar ♂ × Jaer ♀) higher than the corresponding av. production of the mother and paternal grandmother birds.

The plumage of the Jaer crossbreds is described. The day-old chicks, except the Legbar ♂ × Jaer ♀ and the W.L. ♂ × Jaer ♀, were autosexing. (Animal Breeding Abstracts)

EVANS, J. W. 1958.

AN AUTO-SEXING VARIETY OF THE AUSTRALORP FOWL, THE AUSTRALBAR. *Aust. vet. J., 34:* 296-298. (Aust. vet. Conf.)—For some 15-20 yrs. brown sports have been appearing in certain Black Australorp flocks [? in Victoria]. These chicks have a down pattern of longitudinal brown, light and dark stripes. In order to investigate the possibility of developing a new autosexing silver breed [Australbar] from the brown Australorp, breeding experiments were begun in 1952. These are described. By the end of 1957, 3 ♂ ♂, each heterozygous for barring, silver and rapid feathering, had been mated with a few barred ♀ ♀. Among the progeny, 17 chicks lacked the colour pattern of body and head, and appeared grey; all were ♂ ♂. One of these when mated with a small pen of barred ♀ ♀ sired 37 progeny which were sexed by colour with 97% accuracy. It is considered that with greater numbers accuracy would approach 100%.

Reciprocal matings between R.I.R.s and the brown flock indicate that there would be no benefit in attempting to utilise barring for sex linking with R.I.R., or with New Hampshire stocks. However, the barring would probably be satisfactory in determining sex in crosses using Brown Leghorns or extended black ♂ ♂. It is believed that Australbar ♂ ♂ mated with White Leghorn ♀ ♀ will produce a cross indistinguishable from the commercial W.L./Australorp cross but more economical than the latter, as the W.L. hen has a lower maintenance requirement than the Australorp hen. (Animal Breeding Abstracts)

GALJPERN, I. L. 1958. [Pushkin Res. Lab. Livestock Breed., Leningrad.] Vlijanie inoporodnogo semeni na kacestvo potomstva u kur.

THE EFFECT OF SEMEN OF A DIFFERENT BREED ON THE QUALITY OF PROGENY IN THE FOWL. *Z. obsc. Biol., 19:* 217-225.

[English summary.]—In 1955-56, of 3 groups each of 58 Australorp hens, the control ♀♀ were mated with purebred Australorps, and the 2 experimental groups were mated with Australorp and Russian White ♂♂ alternately at 7-day and 1-day intervals resp. Embryonic mortality and the percentage infertile eggs were greatest in the control group and least in the group in which matings occurred daily, in which group hatchability was highest. In the 2 experimental groups 54.7 and 50.6% of the chicks were purebreds. The body weight of the experimental purebreds was greater than that of the control purebreds; it was greater in the crossbreds than in the experimental purebreds. The experimental pullets came into production earlier than the control pullets and in the first 9 mths. produced a greater number of eggs. (Animal Breeding Abstracts)

GODFREY, E. F. 1957. [Ohio State Univ., Columbus.]

THE GENETIC CONTROL OF ADULT BODY SIZE IN THE DOMESTIC FOWL. *Diss. Abstr., 17:* 2745-2746.—The 1st part of the study involved Rose Comb Black Bantams, Barred Plymouth Rocks, the F_1, F_2 and F_3 crosses between them, and the backcross of F_1 ♂♂ to New Hampshire ♀♀ [*see A.B.A., 21,* No. 1927]. As mean body weight in the F_1 and F_2 birds at 30 wks. of age was below the intermediate parental weight, it is concluded that the gene complex controlling body size in Bantams is dominant over that in Barred Plymouth Rocks. The weight of the F_1 birds exceeded the intermediate parental weight until 12 or 16 wks. of age, indicating heterosis for early growth rate. Larger body size appeared to be associated or linked with sex-linked silver and sex-linked slow feathering. The major action of the sex-linked gene(s) affecting body size appeared to be exerted prior to 6 wks. of age. Differences in adult body size reflected differences in growth rate prior to 6 wks. The sex-linked body size gene(s) seemed to be recessive in the Bantam parents and dominant in the Barred Plymouth Rocks. The contrasting alleles caused approx. 10% difference in body weight at all ages. The number of genes influencing body size at 30 wks. of age was estimated to be at least 16 pairs. The F_2 generation was the most variable in both body weight and shank length and the F_1 generation was the least variable. Within generations, the greatest variability was usually at 6 wks. of age.

The 2nd part of the study dealt with the influence of egg weight, chick weight and egg shape on post-natal growth. White Plymouth Rocks were used in addition to the parental stocks used in part 1. On the basis of data from 208 Rose Comb Black Bantams, 345 Plymouth Rocks, 313 Bantam ♂×Plymouth Rock ♀ crosses and 108 Plymouth Rock ♂×Bantam ♀ crosses, it is concluded that egg size causes only a temporary retardation in the continuous growth pattern of the chick. Its effect on body size is greatest just before and after hatching.

As post-natal growth proceeds, the influence of egg size decreases and eventually disappears. Egg shape appears to have no direct effect on chick weight. Male chicks utilised from 0.75% to 1.47% more of the egg for embryonic development than did ♀♀, and chicks from the larger parental breeds utilised from 3.70 to 6.94% more of the egg than did the Bantam chicks. Crossbreds hatched from Plymouth Rock eggs utilised 1.84 to 2.08% less of the egg than did purebred Plymouth Rock chicks hatched from eggs of the same size, whereas crossbreds hatched from Bantam eggs utilised as much of the egg as did purebred Bantam chicks. (Animal Breeding Abstracts)

HENDERSON, E. W. 1958. [Dep. Poult. Husb., Michigan State Univ. Agric. Exp. Sta., East Lansing.]

CAN SEASONAL VARIATION IN HATCHABILITY DEPEND ON SAMPLING METHODS? *Quart. Bull. Mich. agric. Exp. Sta., 41:* 225-231.—The results of 2 methods of sampling of breeding stock for production of hatching eggs for comparing early (mid-winter) and late spring (May and June) hatches were demonstrated.

In the 1st sample, 10 lots of 10 hens were selected at random from the flock records of Michigan Agricultural Experiment Station Project 266. Random selection placed no restriction on numbers of eggs set in either season. This procedure simulated the common "random" method of choosing lots of hens for test purposes. Detailed individual hatching data were then recorded to demonstrate hidden bias that could result from a random selection method.

In order to permit statistical analysis, another sample of 100 hens was chosen at random from the flock with the restriction that each hen must have had a minimum of 5 fertile eggs set in each season.

Sampling methods designed to avoid bias and biometric methods appropriate for small restricted samples were demonstrated.

Individually pedigreed hens of proved merit are recommended for testing the influence of refined chemical compounds or trace elements on hatching power. (Animal Breeding Abstracts)

HOGSETT, M. L., and **A. W. NORDSKOG.** (Iowa State Coll., Ames.)
GENETIC - ECONOMIC VALUE IN SELECTING FOR EGG PRODUCTION RATE, BODY WEIGHT AND EGG WEIGHT. Poultry Sci. 37(6) : 1404-1419. 1958.—Data from the records of 1938 birds representing 7 breeds were used to estimate phenotypic and genetic parameters influencing egg production, mature body weight and egg weight. These results, combined with others in the literature, were used to obtain a selection index. Depending on the valid application of assumptions, use of this index in a breeding program would result in a relatively large genetic decrease in body weight and egg weight. Thus, indiscriminate use of an index which is supposed to maximize genetic-economic value might lead to undesirable genetic consequence. It was shown that the selection index can be modified such that genetic change for specified traits may be restricted. It is possible, for example, to develop an index which permits no genetic change in egg weight, but otherwise is designed to maximize genetic-economic value. For the traits considered such an index was constructed and as shown to be 92% as efficient as the unrestricted selection index in promoting net improvement in genetic-economic value. An index designed to hold both body weight and egg weight constant (i.e., in genetic equilibrium) was 50% as efficient as the unrestricted index. (Biological Abstracts)

JULL, MORLEY A.
CONSIDERABLE PROGRESS ACHIEVED IN BREEDING FOR INCREASED EGG PRODUCTION IN EGYPT. World's Poultry Sci. Jour. 14(3) : 200-202. Illus. 1958.—Fayoumi, White Leghorn crosses gave higher egg production than either pure breed. The Rhode Island Reds used layed fewer eggs than did the Leghorns, and the crosses with the Fayoumi were inferior to the corresponding Leghorn crosses for egg production. Fayoumi eggs averaged 40.88 g and were smaller than those from Reds or Leghorns. Crosses were intermediate in this. Feed consumption differences were mostly secondary. (Biological Abstracts)

KATSURAGI, T., and **Y. SAEKI.** 1958 [Dep. Livestock, Nat. Inst. Agric. Sci., Chiba Shi.]
SEASONAL VARIATION OF SPERMATO-GENESIS IN THE DOMESTIC FOWL. *Jap. J. zootech. Sci., 29:* 21-24 [Japanese with English summary.]—A study was made of seasonal variations in semen quality and in the histology of the testis. Semen was collected twice monthly. For the histological studies 23 cocks were killed at 4 different periods. The largest volume of semen (0.23 cm^3) was obtained in spring and the smallest volume (0.18 $cm.^3$) in summer. The number of spermatozoa per cm^3 averaged 2.36 billion in spring, 1.99 billion in autumn, 1.90 billion in winter and 1.71 billion in sumer. The duration of sperm survival in semen kept at about 8°C. in an electric refrigerator was longest (119 hrs.) in May, but seasonal variations in this respect

were not large. Testes examined in March showed the greatest spermatogenic activity, and those examined in Aug. the least. Neither spermatids nor mature spermatozoa were present in Aug. Individual differences in semen quantity and quality were observed. (Animal Breeding Abstracts)

KAUFMAN, L., and **H. KRZANOWSKA.** 1957. [Exp. Biol. Unit, Zootech. Inst., Pulawy.] Badania and „starzeniem sie" jaj. III. Wplyw przechowywania jaj na ciezar ciala i niektorych narzadow, zawartosc glikogenu w watrobie, zawartosc hemoglobiny krwi i budowe histologiczna tarczycy pisklat.

INVESTIGATIONS OF THE "AGING" OF EGGS. III. EFFECT OF THE STORAGE OF EGGS ON THE BODY AND ORGAN WEIGHTS OF THE CHICKS, THE GLYCOGEN CONTENT OF THE LIVER, THE HAEMOGLOBIN CONTENT OF THE BLOOD, AND THE HISTOLOGY OF THE THYROID. *Roczn. Nauk. rol., B. 72:* 385-395. [Russian and English summaries.]—A comparative study was made of 20 Greenleg chicks hatched from eggs incubated not more than 8 days after being laid and 20 chicks of the same breed hatched from eggs stored at 10°C. for 16-21 days prior to incubation. On the day of hatching, chicks hatched from "fresh" eggs weighed more than those hatched from stored eggs and the amount of unabsorbed yolk was smaller. The growth of the embryo started about 24 hrs. later in stored eggs and hatching was delayed by about 16 hrs. The period of embryonic life was therefore shorter in the case of chicks from stored eggs, but there was a tendency to compensate for retarded embryonic development by an increased rate of metabolism after hatching. (Animal Breeding Abstracts)

KOPYLOVSKAJA, G. Ja., A. A. NIKOLAEV, A. V. AFONINA, and **M. Ja. DYRENKOVA.** 1958. Rezuljtaty ispytanija „gibridnoi" pticy v sovhoze „Pticnoe". Moskovskoi oblasti.

RESULTS OF TRIALS WITH "HYBRID" BIRDS AT THE STATE FARM "PTICNOE" IN THE MOSCOW PROVINCE. *Ptice-vodstvo, 8(10):* 24-27.—In 1956, 3 groups of hatching eggs were received at the farm from the U.S.A. The eggs were produced by between-line crossing of White Leghorns, by crossing lines of Rhode Island Reds with lines of New Hampshires, and by using W.L.s from crossed lines on R.I.R.×N.H. crossbreds; local New Hampshires and R.I.R.s, and Russian Whites were used for comparison. The hatchability of the imported eggs was lower than that of the Russian Whites. The body weight of the W.L. chicks was not appreciably different from that of the Russian Whites; that of the 2-breed and 3-breed crossbreds was between that of the parent breeds. In general the production of the 2-breed and 3-breed crossbreds was better than that of the W.L. line crosses. Further matings were made in 1957. (Animal Breeding Abstracts)

KUSNER, H. F. 1957. [Inst. Genet., Acad. Sci. U.S.S.R.] Vlijanie metaboliceskih faktorov na nasledstvennostj zivotnyh.

THE EFFECT OF METABOLIC FACTORS ON INHERITANCE IN ANIMALS. *Agrobiologija,* 1957 *(1):* 19-35.—The literature on the transfer of ovaries, testes, zygotes and blood in livestock and poultry is reviewed. In 1954 a series of experiments with blood tranfer was carried out. When 7 purebred White Leghorn hens to which New Hampshire blood was transferred were mated with untreated W.L. ♂♂, 20 of 90 chicks hatched had some pigmented feathering while 70 had the normal W.L. plumage. When 8 untreated W.L. hens were mated with W.L. cocks to which N.H. blood was transferred, none of the chicks had abnormal feathering. When both the W.L. ♂♂ and the W.L. ♀♀ had N.H. blood transfers none of the chicks had pigmented feathering. W.L. ♀♀ to which wild duck blood was transferred were mated with untreated W.L. ♂♂ and 8 out of 45 chicks had pigmented feathering.

The ♀ chicks so produced were placed in 4 groups of which one with pigmented feathering and one with white feathering were given further blood transfers from N.H.s or from wild ducks and the other 2 groups were not given further transfers; they were all mated with F_1 ♂♂ with pigmented feathering. The hens with pigmented feathering, whether or not they had blood transferred, produced the highest percentages of chicks with pigmented feathering. The white hens which had not had blood transfers produced more chicks with pigmented feathering than did untreated hens from untreated parents. (Animal Breeding Abstracts)

KUSNER, H. F. 1958. Nasledovanie u kur izmenenii v okraske operenija, vozniksih pod vlijaniem perelivanija cuzerodnoi krovi.

INHERITANCE OF CHANGES IN THE FEATHER COLOURING OF FOWLS SUBJECTED TO FOREIGN BLOOD TRANSFUSION. *Z. obsc. Biol., 19:* 357-368. [English summary.]—Work on developing the first 2 generations of White Leghorns with pigmented feathering is summarised [*see* No. 479]. The 2nd generation birds were grouped similarly to the 1st generation birds to produce the 3rd generation. The percentage of birds with pigmented feathering was as great in the 3rd as in the 2nd generation, varying from 19 to 34 in the various groups. The percentage of progeny with pigmented feathering was greater when sired by ♂♂ with pigmented feathering; it did not differ appreciably between white dams and dams with pigmented feathering, or between dams that had or had not blood transfers. The degree of pigmentation on the progeny was not related to that on the parents. Similar results were obtained when the blood donors were semi-wild grey ducks, and when blood from New Hampshires was centrifuged and the plasma used.

The experiments of Benoit *et al.* with Pekin ducks injected with DNA extracted from isolated nuclei of Khaki Campbell ducks are described and their results and those obtained by the author are discussed. (Animal Breeding Abstracts)

KUSNER, H. F., and I. E. NOVIK. 1958. [Inst. Genet., Acad. Sci. U.S.S.R.] Eksperimentaljnye dannye o polovom processe u kur.

EXPERIMENTAL DATA ON THE SEXUAL PROCESS IN THE FOWL. *Zivotnovodstvo, 20(8):* 55-61.—Phosphorus isotopes (P^{32}) were introduced into the blood stream of adult cocks. The percentage of marked spermatozoa in ejaculates increased to a maximum 5-6 days after treatment and then gradually decreased, indicating that the development of spermatozoa continues for 5-6 days. When the semen ejaculated at various intervals after treatment was centrifuged, the amount of P^{32} decreased in the seminal plasma and increased in spermatozoa as the interval between treatment and ejaculation increased.

Various experiments were carried out in which ovulated or unovulated ova were transferred between inseminated and noninseminated hens. It was shown that spermatozoa did not penetrate the membrane of non-ovulated ova; and that ova transferred immediately after ovulation from an inseminated hen to the oviduct of a non-inseminated hen had not already been fertilised. When the donor was not inseminated and the recipient was inseminated, the transferred ova were fertilised whether they had ovulated naturally or had been artificially freed from the membrane. When the yolk of an egg was extracted from the oviduct of an inseminated hen and transferred to that of a noninseminated hen, fertilisation occurred; in the case of the reciprocal transfer this was not so. It is concluded that fertilisation occurs when the ova, after ovulation, reach the upper sections of the oviduct.

Hens were kept apart from ♂♂ for 6-8 mths. before mating. Spermatozoa were observed in the vagina 1-2 hrs. after mating, in the uterus 5 hrs. after mating, in the lower part of the oviduct 24 hrs. after mating, and throughout the oviduct 4-5 days after mating. Spermatozoa were still present in the oviduct more than 30 days after mating. (Animal Breeding Abstracts)

MORLEY, F. H. W. 1958. [Div. Plant Industr., C.S.I.R.O., Canberra.] UTILIZATION OF HETEROSIS IN POULTRY. *Aust. J. agric. Res., 9:* 599-608.—Records were analysed of 500-day production, egg weight, 11-wk. and mature body weight, sex maturity, and broodiness of the crossbred progeny of inbred lines of Australorps mated to White Leghorns, and inbred lines of White Leghorns mated to Australorps. Clear differences between lines of both breeds were found in most characters, indicating the presence of potentially useful amounts of additive genetic variation. Non-additive genetic variation was also found to be present in varying degrees in different characters. Because of the difficulties of developing and maintaining inbred stocks of poultry, and the importance of sex-linked characteristics in some commercial environments, a scheme is proposed which may enable heterosis to be exploited without the use of inbred material. The basis of this scheme is the combination of the White Leghorn sex chromosome, with varying proportions of Australorp and White Leghorn autosomes, in a new breed. Assuming that the heterosis observed in the F_1 is due to elimination of certain biochemical blocks determined by recessive genes, the formation of the new breed should enable the methods of closed flock breeding to be used in material at a higher level of production, and likely to contain more genetic variability, than either parent breed. (Animal Breeding Abstracts)

PENIONZKEVIC, E. E., I. K. SAVELJEV, N. P. TRETJJAKOV., and **A. G. NAHLUPINA.** 1958. Zagorskaja porodnaja gruppa kur. THE ZAGORSK BREED GROUP OF FOWL. *Ptícevodstvo, 8(8):* 23-29.—Methods used in developing the Zagorsk fowl at the All-Union Poultry Breeding Research Institute are described. In 1950 reciprocal crosses were made by mating Russian Whites with Yurlovs, Rhode Island Reds and New Hampshires; the 1st generation birds were mated with R.I.R.s and the 2nd and 3rd generation birds with Yurlovs. Further development was by *inter se* breeding. The birds are dual-purpose. There are 2 varieties: one is white with a rose comb; the other has pinkish plumage on the head, back and wings, yellow plumage on the breast, a brown tail, white on the underside and a leaf comb. (Animal Breeding Abstracts)

PIGAREV, N. V., L. A. MAKOGON, and **N. V. NIKOLOTOVA.** 1958. [All-Un. Inst. Poult. Industr. Res.] Vosproizvoditeljnye sposobnosti kur pervogo goda jaicekladki. REPRODUCTIVE ABILITY OF HENS IN THEIR PULLET YEAR. *Ptícevodstvo, 8(7):* 28-32.—At the Glebovskii Hatchery eggs from Russian Whites of various ages were incubated in Jan.-Oct. 1955 and of 6888 chicks reared 1894 ♀♀ were housed in individual laying cages. The greatest percentage of fertile eggs (96) was laid by 8- to 9-mth. pullets and hatchability was highest (88-90% of fertile eggs set) in eggs laid by 8- to 12-mth. pullets. Chick mortality was lowest in chicks produced by older hens and in those hatched from large eggs. The rate of growth of chicks hatched from small eggs was greater than that of chicks hatched from large eggs; the difference in adult body weight was not great. When the ♀♀ came into production their body weight and the size of the eggs they laid were found to be related to the size of the egg from which they hatched and to the age of their dams. (Animal Breeding Abstracts)

PILLA, A. M. 1958. [Sta. Sper. Pollicolt., Rovigo.] Precocita nell'impennamento e rapidita di sviluppo nel pollo da carne. EARLY FEATHERING AND RATE OF GROWTH IN BROILERS. *Ann. Sper. agr.,* N.S. *12:* 1157-1173. [English summary.]—The criteria used in determining whether feathering is late or early at 1, 10, 30 and 60 days are described. The conclusion of other authors, namely that early feathering is inherited as a simple, sex-linked recessive, was confirmed in crosses between a New Hampshire cock and 4 Plymouth Rock hens. The presence amongst the offspring of one of the crosses,

however, of ♂ ♂ with early feathering, points to the possible existence of a sex-linked gene which inhibits the expression of the dominant allele for rate of feathering in homozygous ♂ ♂.

Live weight at 60 days and rate of feathering were determined in the offspring of 10 N.H. hens mated with 2 cocks of the same breed. No significant correlation could be found between the 2 variables. (Animal Breeding Abstracts)

POLIVANOVA, T. M. 1958. Arzamasskie gusi.

ARZAMAS GEESE. *Ptitsevodstvo, 8(9):* 20-23—Arzamas geese are bred in central Russia around the Volga, Oka and Kama Rivers. A State Breeding Co-operative for breeding them was set up in 1949 with over 2,000,000 geese. In 1958 av. body weight was 6.0 kg. for ♂ ♂ and 5.5 kg. for ♀ ♀. The meat is of a good quality and production averages 14.3 eggs. (Animal Breeding Abstracts)

QURESHI, S. H. 1958. [Anim. Husb. Dep., Peshawar, West Pakistan.]

EFFECT OF ADDITION OF SEX HORMONES TO CHICKEN SEMEN WITH AND WITHOUT ANTIBIOTICS ON THE LIVABILITY AND FERTILIZING CAPACITY OF SPERMATOZOA. *Pakist. J. sci. Res., 10*: 13-19.—Semen was collected from 6 New Hampshire cocks, diluted at a rate of 1 : 9 in isotonic NaCl or Na citrate and stored at 10°-12° C. The addition, before storage, of testosterone propionate (100-400 μg./ml.) or diethylstilboestrol (40-100 μg./ml.) appeared to result in a slight increase in sperm survival time. Survival time was definitely increased by the addition of 700 μg./ml. streptomycin+either 200 μg./ml. testosterone propionate or 160 μg./ml. diethylstilboestrol; it ranged from 6 to 14 days *v.* 4-5 days in controls.

The fertility of the diluted semen stored for 8 hrs. at 10°-12° C. was assessed by inseminating hens and determining the percentage of fertile eggs laid during the week beginning on the 2nd day after insemination. Percentage of fertile eggs was 27.2-43.9% following insemination with semen treated before storage with 160 μg./ml. testosterone propionate+500 μg./ml. streptomycin, and 13.6-56.25% when 160 μg./ml. diethylstilboestrol was substituted for ♂ hormone; untreated semen gave figures ranging from 5 to 30.4%. Percentage of fertile eggs laid during the 2nd wk. after insemination was nil following the use of stored semen except in 2 trials, when it was 12.5% in the case of treatment with ♂ hormone and 30.7% in the case of treatment with ♀ hormone. It was 26.0-27.0% when diluted semen was inseminated immediately after collection. (Animal Breeding Abstracts)

RITCHIE, G. B. 1958.

A MODIFICATION OF THE "DOUBLE-CROSS" TECHNIQUE OF BREEDING HYBRID POULTRY. *J. Hered., 49:* 110, 116.—In the "double-cross" technique 4 inbred lines are mated together in pairs to give 2 F_1's, which are then mated to give a so-called "double-cross" generation. The production of commercial double-cross birds involves at least 7 different matings every season. It is, however, possible to produce a cross involving only 3 different matings which is exactly the same as the double-cross, apart from specific epistatic effects and possible slight recombination and maternal effects. This can be achieved by breeding the F_2 birds together at random and in sufficient quantity to avoid inbreeding effects. The population thus produced can be maintained by random mating with its composition virtually unchanged except by the effects of natural selection and recombination. Its mean yield should be higher than that of the original inbred parents although not as high as that of the parent F_1's. If the cross between the F_2's proves, in practice, to be as similar to the conventional double-cross as would appear in theory, the parent lines can be discarded and only the two F_2 flocks need be maintained and the cross made between them. (Animal Breeding Abstracts)

SANDVIK, O. 1958. [Inst. Anim. Breed. Genet., Agric. Coll. Norway, Vollebekk.]

THE EFFECT OF CHRONIC GAMMA RADIATION ON THE HATCHABILITY OF CHICKEN EGGS. *Hereditas* [*Lund*] *44:* 407-414.—In 2 experiments, 1316 eggs in all were subjected to doses of gamma rays ranging from 3700 r to 270 r. The duration of irradiation varied from 6 to 144 hrs. The irradiated eggs took a longer time to hatch than did the controls. In eggs irradiated with doses greater than 1584 r no embryos were detected by candling after 6 days of incubation. No egg receiving more than 1080 r hatched. Twelve abnormal embryos from eggs that did not hatch are briefly described. (Animal Breeding Abstracts)

SAPOVALOV, Ja. Ja., A. S. SEREBRJAKOV, and **N. E. GORODKOVA.** 1958. Kucinskie obscepoljzovateljnye kury i ih daljneisee soversenstvovanie.

KUCHIN GENERAL-PURPOSE FOWLS AND THEIR FURTHER IMPROVEMENT. *Pticevodstvo, 8(9):* 16-19. The development of the Kuchin breed is described. In the Kuchin fowl body weight is greater and meat quality better than in the Russian White. The Kuchins average 119.3 eggs per yr. *v.* 103.7 for the Australorps and 104.1 for the Plymouth Rocks; laying continues throughout the year. Hens with a body weight of 2.8-3.0 kg. have the highest egg production. No direct relation was found between the egg production of the dams and that of the daughters. The Kuchin breed is kept in a number of provinces, territories and republics of the U.S.S.R. (Animal Breeding Abstracts)

SEBESTYEN, G., and **I. MORVAI.** 1958. [Dep. Anim. Breed., Univ. Agric. Sci., Godollo.] Adatok a sarga magyar tyuk nehany ertekmero tulajdonsaganak atoroklesehez

THE INHERITANCE OF SOME OF THE CHARACTERS OF THE HUNGARIAN YELLOW FOWL. *Allattenyesztes, 7:* 149-154. [Russian and German summaries.]—Using full-sib and half-sib comparisons heritabilities were calculated for age at first egg, winter production and intensity of production. It is concluded that heritabilities were more accurate when based on full-sib comparisons.—Abstract of summaries. (Animal Breeding Abstracts)

SOKOLOVA, A. N. 1958. Selekcija kur na vysokuju. produktivnostj i ustoicivostj k ponizennym temperaturam.

SELECTION OF FOWLS FOR HIGH PRODUCTION AND ADAPTABILITY TO LOW TEMPERATURE. *Pticevodstvo, 8(9):* 26-29.—At the Biological Institute of the Leningrad State University 6 generations of Russian Whites were selected for adaptability to low temp. The experimental flock was kept in an av. temp. of 17° until adult, after which winter temp. averaged −11°; the control flock was kept at 19° throughout. In the 5th generation of the experimental flock hatchability averaged 85.1% *v.* 81.7% for the controls. The body weight of the experimental birds was higher although food consumption was no greater. In their 1st laying year the experimental birds averaged 176 eggs and the controls 161. (Animal Breeding Abstracts)

TEBB, G. 1958. [Poult. Res. Centre, Edinburgh.]

INTRA-GENERATION INBREEDING EFFECTS IN A POULTRY FLOCK SELECTED FOR EGG PRODUCTION. *Heredity, 12:* 285-299.—A statistical study was made of effects likely to be operative in most cases of selection in closed flocks, *i.e.* when the rate of increase in the inbreeding levels is minimal for the size of the flock, when flock size is relatively large, and when selection for some component of fitness has been effective. The S.C. White Leghorn flock used in the investigations at the University of California had been subject to continuous selection for egg production since 1932 and had been a closed flock since 1941. The results appear to indicate that inbreeding has a detrimental effect (rarely reaching statistical significance) on nearly every

factor contributing to production and that this effect is particularly evident in times of stress. (Animal Breeding Abstracts)

V[AN] ALBADA, M. 1958. ["Het Spelderholt" Inst. Poult. Breed., Beekbergen.] Invloed van erfelijke- en omgevingsfactoren op het legritme van de kip.

INFLUENCE OF HEREDITARY AND ENVIRONMENTAL FACTORS ON THE LAYING RHYTHM OF THE HEN. *Tijdschr. Diergeneesk., 83:* 920-931. [English, French and German summaries.]—In White Leghorns the following factors were found to be correlated with annual yield: age at 1st egg ($r = -0.432$), age at last egg ($r = +0.596$), length of the laying year ($r = +0.664$), lay to 1st Feb. ($r = +0.718$), av. length of the laying cycle to the age of 9 mths. ($r = +0.489$), av. cycle length over the whole year ($r = +0.606$) and av. egg weight ($r = +0.108$). Particular emphasis is laid on the importance of the length of the laying cycle. The coefficient of correlation between av. cycle length in the 2-mth. period following the laying of the 1st egg and annual egg yield (+0.618) was higher than those obtained when the av. laying cycle was calculated for periods of 4 mths. ($r = +0.574$) or 6 mths. ($r = +0.597$). It is concluded that the best criteria for high egg yield are the av. length of the laying cycle and age at 1st egg. Selection for these 2 characters appears to be more effective than direct selection for number of eggs. The biological processes associated with individual differences in the length of the laying cycle are reviewed, special attention being paid to the influence of the light regime. (Animal Breeding Abstracts)

WAWRZYNIAK, M. 1958. [Dep. Anim. Anat., Vet. Fac., Agric. Coll., Lublin.]

HISTOPHYSIOLOGIC STUDIES OF THE INFLUENCE OF THE ASCORBIC ACID ON SPERMIOGENESIS IN COCKERELS. *Ann. Univ. M. Curie-Sklodowska, DD, 11* (1956): 1-56. [B.] [Polish and Russian summaries.]—In a preliminary study carried out in 1953 it was found that the intramuscular injection of vitamin C caused an acceleration of spermatogenesis in Polish Greenleg cockerels. The aim of the present series of experiments was to confirm this result and to determine whether the dosage of vitamin C, and the age of the cockerel are correlated with the intensity of the spermatogenetic process. Of 175 cockerels used, 45 were Greenleg×Sussex crosses, the remainder being purebred Greenlegs or White Leghorns. Vitamin C (0.5 $cm.^3$) was injected into the breast muscles of birds of various ages (21, 35 and 49 days) at 14, 20 or 28 twelve-hr. intervals. The control groups were injected with physiological saline. All the birds were killed at 70 days of age.

In general, although not invariably, vitamin C had an accelerating effect on spermatogenesis. The increased spermatogenetic activity was usually accompanied by an increase in testis weight. Best results were obtained with 28× 0.5 ml. vitamin C injected every 12 hrs. into cockerels aged 35 days. As the mortality rate was significantly greater in the control than in the experimental birds, it appears that vitamin C may also produce immunity to disease organisms, especially in the early weeks of the chick's life. (Animal Breeding Abstracts)

WENDT, E., 1958. [Zool. Inst., Univ. Bonn.] Das. Verhalten der Melanoblasten verschiedener Huhnerrassen (Seidenhuhn und Leghorn) in Gewebekulturen.

THE BEHAVIOUR OF THE MELANOBLASTS OF DIFFERENT BREEDS OF FOWL (SILKIE FOWL AND LEGHORN) IN TISSUE CULTURES. *Roux' Arch. Entw-Mech. Organ., 150:* 495-508.—Genetically determined differences were found between the melanoblasts of white-feathered Japanese Silkie Fowls, which carry the dominant factor *P*, responsible for pigmentation of the connective tissue, and those of White Leghorns [*pp*]. Up to the 7th day of embryonic development pig-

mentation of the internal body cells differs only quantitatively in the 2 breeds. About the 7th day, however, the pigment cells in the White Leghorn begin to degenerate, whereas those in the Silkie Fowl greatly increase in numbers. Evidence is presented in support of the hypothesis that melanoblast degeneration in the White Leghorn is due, not to the presence of an inhibitor, but to the absence of an activator. The activator is probably formed in the melanoblasts themsleves. (Animal Breeding Abstracts)

WILCOX, F. H. 1958. [Dep. Poult. Husb., Univ. Maryland, College Park.] STUDIES ON THE INHERITANCE OF COLOBOMA OF THE IRIS IN THE DOMESTIC FOWL. *J. Hered., 49:* 107-110.—Closely related White Leghorn hens that had coloboma of one iris or that had dams or sisters with this defect were mated to a ♂ with coloboma. Classification of chicks from these matings at 6 wks. of age showed 22.0% with coloboma of one or both irises. Affected birds from families with a high incidence were then mated together, and an incidence of 27.9% was observed in their progeny. The incidence of coloboma was twice as great in ♀♀ as in ♂♂. Bulging eye and sunken eye were also observed in this stock. The results obtained have provided evidence that coloboma of the iris is inherited, and it is suggested that an undetermined number of genes are operating with low penetrance. (Animal Breeding Abstracts)

WILCOX, F. H., and **M. S. SHORB.** 1958.
THE EFFECT OF ANTIBIOTICS ON BACTERIA IN SEMEN AND ON MOTILITY AND FERTILIZING ABILITY OF CHICKEN SPERMATOZOA. *Amer. J. vet. Res., 19:* 945-949.—It has been suggested that the poor results obtained with stored cock semen might be due to failure to control bacterial growth, which is much greater than in bull semen. Seven different antibiotics at various levels were tested for their effect on motility of cock semen after storage for 24 and 120 hrs. at 10° C. Bacterial counts were also determined in semen stored for 48 hrs. with the antibiotics separately and in various 2-way combinations. The 2 most promising combinations were 450 units penicillin +450μg. dihydrostreptomycin/ml., and 90 μg. oxytetracycline+900 μg. dihydrostreptomycin/ml., which were then tested for their effect on fertility. Only the former resulted in a marked improvement of fertility in stored semen. The failure of the latter to bring about any improvement in this respect, in spite of its effective antibacterial action, is discussed. (Animal Breeding Abstracts)

PHYSIOLOGY

AGRICULTURAL RESEARCH. 1958.
THYROIDS AND HEAT TOLERANCE. *Agric. Res.* [*U.S. Dep. Agric.*], *7(2):* 7.—The results are outlined of tests made by M.H. Conner, H. Menge and H. Ota in which chicks from 2 genetic lines of New Hampshires, bred for difference in thyroid size, were exposed to constant (24 hrs. per day) high temps. Compared with the large-thyroid chicks, the small-thyroid chicks weighed less after exposure to 95° F., and had a 33% higher mortality rate after exposure to 100° F. Survivors among the small-thyroid birds had smaller body and thyroid weights. Although high temps. depressed the development of the thyroid gland in both lines, the difference in thyroid size between lines remained constant. (Animal Breeding Abstracts)

BLACKWOOD, UNABELLE BOGGS, and **MARY S. SHORB.** (U. Maryland, College Park.)
LETHAL EFFECT OF CERTAIN BENZIMIDAZOLES AND BENZENES ON THE EARLY CHICK EMBRYO. Proc. Soc. Exptl. Biol. and Med., 99(1): 232-235. 1958.—The lethality of 7 compounds structurally related to vitamin B_{12} was determined by injecting several doses of each compound into the albumen prior to incubation. The lethal

index (percent dead/μM of inhibitor/egg) for each compound was: (I) methylamide, 0.5; (II) 1,2-dimethyl-4,5-diaminobenzene, 2.8; (III) 5,6-dimethylbenzimidazole, 3.7; (IV) 2,5-dimethylbenzimidazole, 8.0; (V) 1,2-dichloro-4,5-diaminobenzene, 9.5; (VI) 2-ethyl-5-methylbenzimidazole, 12.6 (injected Oct.-Nov., random bred, White Leghorn); (VII) 2-hepta-5-methylbenzimidazole, 15.5; and (VI) 2-ethyl-5-methylbenzimidazole, 29.0 (injected Feb.-March, Mt. Hope, White Leghorn). The effect of vitamin B_{12} was tested on compounds V, VI, VII; it alone was non lethal and failed to influence the lethality of V and VII. However, high levels partially reversed VI under conditions which varied with seasonal and/or genetic differences. The lethality of the VI also varied under these conditions. The relative order of lethality of the benzimidazoles was the same as in virus inhibitory work, (Tamm et al., J. Exp. Med. 98: 245. 1953) while that of the benezenes was the same as the inhibition of microorganisms which synthesize B_{12} and/or riboflavin (Woolley, Proc. Soc. Exp. Biol. Med. 75: 745. 1950). The 3 inhibitors which are natural moities of vitamin B_{12}, I, II, and III, were the least lethal of the compounds tested. The implications of these findings were discussed. (Biological Abstracts)

CAIRNS, JOHN M., and **JOHN W. SAUNDERS, Jr.,** (U. Texas, Austin.)
THE INFLUENCE OF EMBRYONIC MESODERM ON THE REGIONAL SPECIFICATION OF EPIDERMAL DERIVATIVES IN THE CHICK. J. Exp. Zool., 127(2): 221-248. Illus. 1954.—Isolates of ectoderm-free leg mesoderm grafted to the wing bud of the 3 1/2 to 4-day chick embryo are soon covered by wing ectoderm. This combination of tissues forms characteristic scales, claws and leg feathers. In some cases, the feathers which form on the wing as a result of the operation are typical of the leg in the most intimate details of their structure. Clearly, therefore, the local character of the underlying limb mesoderm exercises an influence in the determination of specific morphogenetic activities in the covering layer of ectodermal cells. (Biological Abstracts)

FOULKES, ROBERT H., JOHNATHAN PARSONS, and **H. FREDERICK SCHUKNECHT.** (Edsel B. Ford Inst. Med. Res., Detroit.)
X-RAY DIFFRACTION OF OTOLITHS AND EGG SHELLS OF BIRD AND REPTILE. Amer. Nat. 92(866): 319. 1958.—Dry, powdered unfixed preparations of shells and otoliths were examined Calcium carbonate occurs in 2 crystal forms, calcite or aragonite in the egg shell. Otoliths also form 1 or the other type crystal. In birds, calcite is the form found in both structures (White Leghorn hen). In the turtle, *Emys blandingi*, the egg shell is aragonite. Previously no turtle otoliths were reported but in *E. blandingi* they were made of aragonite. (Biological Abstracts)

GLICK, BRUCE. (Mississippi State U., State College.)
THE EFFECT OF CORTISONE ACETATE ON THE LEUKOCYTES OF YOUNG CHICKENS. Poultry Sci., 37(6): 1446-1452. 1958.—The test animals were 3-week-old New Hampshires. The objectives of this experiment were to determine the effect of cortisone acetate after varying periods of time and immediately on the white blood cells. In all trials an initial white cell count was secured at least 24 hours prior to injection. A single injection of 25 and 15 mg of cortisone will, within 3 hours, significantly reduce the relative per cent of lymphocytes and increase the relative and absolute count of heterophils in 3-week-old chickens. Injection of 2.5 mg cortisone reduced the per cent of lymphocytes and increased the per cent of heterophils within 3 hours after injection. Multiple injections of cortisone acetate are effective in reducing the relative number of lymphocytes and increasing the relative and absolute count of heterophils 24-48 hours after the last injection. The data suggest that an initial white cell count determined 24 hours prior to experimental counts is an excellent aid in critically evaluating the effectiveness of cortisone injections. (Biological Abstracts)

JAAP, R. GEORGE. (Ohio Agric. Expt. Sta., Columbus.)
LARGE BURSAE FABRICII IN LEGHORN-TYPE BABY CHICKENS. Poultry Sci. 37(6): 1462-1464. 1958.—Samples of 100 or more baby chickens of the same sex from 12 strains and crosses demonstrated that the bursa of fabricius was heavier at hatching time in Leghorns than in large adult types. The bursae of a strain cross and an incrossbred Leghorn were larger at hatching than those of another strain cross and 2 randombred Leghorn strains. The question was raised whether the ability of the Leghorn to resist certain diseases, extreme heat and certain feed deficiencies might be attributable to the size or function of this lymphatic gland. (Biological Abstracts)

MEDWAY, WILLIAM. (U. Pennsylvania, Sch. Vet. Med., Phila.)
TOTAL BODY WATER IN GROWING DOMESTIC FOWL BY ANTIPYRINE DILUTION TECHNIC. Proc. Soc. Exptl. Biol. and Med. 99(3): 733-735. 1958.—The total body water of growing White Leghorn pullets as estimated by antipyrine agreed closely with those obtained by desiccation at the ages studied, the range for antipyrine being from 85.2% for a 1 week-old chick to 55% for the 32-week-old bird. (Biological Abstracts)

NEWCOMER, W. S. (Oklahoma State U., Stillwater.)
PHYSIOLOGIC FACTORS WHICH INFLUENCE ACIDOPHILIA INDUCED BY STRESSORS IN THE CHICKEN. Amer. Jour. Physiol. 194(2): 251-254. 1958.—Application of cold (4°C) together with wetness, acute anoxia, restraint or injection of saline (0.2 ml), epinephrine (0.2 mg), histamine (0.2 mg), or formaldehyde (0.2 ml, 40%) was followed by an acidophilia in white leghorn cockerels within 4-8 hours; acidophilia which followed injection of cortisone, hydrocortisone, desoxycorticosterone and aldosterone is consistent with the supposition that the above stressors activate the adrenocortical tissue of the chicken. Hypophysectomy markedly inhibited but did not wholly prevent the acidophilia which followed restraint therefore a nonpituitary factor is probably involved in stressor-induced acidophilia. This latter factor could be epinephrine but is probably not histamine since prior injection of antihistaminic agents did not inhibit restraint-induced acidophilia. (Biological Abstracts)

WINGET, CHARLES M., ARTHUR H. SMITH and GEORGE N. HOOVER. (U. California, Davis.)
ARTERIO-VENOUS DIFFERENCES IN PLASMA CALCIUM CONCENTRATION IN THE SHELL GLAND OF THE LAYING HEN DURING SHELL FORMATION. Poultry Sci. 37(6): 1325-1328. 1958.—The analysis of plasma from the arterial and venous blood of the shell gland indicates that circulating Ca is removed by this organ during shell formation. This organ is about 20% efficient in removing circulating Ca both in the early and late stages of calcification. The concentration of diffusible Ca in the plasma does not appear to be affected by passage through the shell gland. (Biological Abstracts)

WINTER, H. 1958. [Vet. Sch., Univ. Queensland, Brisbane.]
PERSISTENT RIGHT OVIDUCTS IN FOWLS INCLUDING AN ACCOUNT OF THE HISTOLOGY OF THE FOWL'S NORMAL OVIDUCT. *Aust. vet. J., 34:* 140-147.—A histological description of the normal oviduct in the fowl is followed by an account of the findings in an examination for presence of persistent right oviduct in 382 birds culled for low productivity from the inbred Australorp flock at the University Farm, and in 83 birds (considered as controls) at an abattoir. In the Farm lot 307 birds (81%) showed some development of the organ, ranging from a cyst 0.5-20 cm. in diameter to a fully developed right oviduct (6%). Partial development, though much less extensive, occurred in 86% of the controls, 60% having small tubes, mostly less than 1 cm. long and none over 5cm.

Histological examination of 11 cysts and 11 ducts suggested that the remnants have their origin in the infundibulum and albumen regions. (Animal Breeding Abstracts)

ZUCKER, HERMAN, J. C. ATKINSON, R. B. SCHNELL, and **G. A. DONOVAN.** (Chas. Pfizer Co. Inc., Terre Haute, Indiana.)

RELATIONSHIP OF VARIATION TO RATE OF GROWTH. Poultry Sci. 37(6): 1395-1400. 1958.—The relationship of variability to rate of growth and attained weight was investigated at 3 and 4 weeks of age using a total of 2208 pens of New Hampshire chicks. In part 1, data from 23, 3-week uniformly conducted experiments each containing 48 pens was investigated. Both attained weights and coefficients of variation were expressed as indices of the control group for the particular experiment. Highly significant negative correlation and regression coefficients were found. A 1% increase in growth index was associated with a decrease in coefficient of variation of 1.64%. Since the above data were taken only at 3 weeks of age it could not be distinguished if the relationships were due to higher attained weight or faster rate of growth. Hence, in part 2 another series of 23 experiments were selected with weights obtained at 4 weeks of age. Due to the design of the second series of experiments it was not feasable to convert to indices. Therefore, analysis was made of weights and coefficients of variation for both the 3 and 4 week sets. High significant negative correlation and regression coefficients were found within both the 3 and 4 week data. A weight increment of 100 g at 3 or 4 weeks resulted in a reduction of the coefficient of variation by 2.8% units and 5.8% units respectively. In part 3 data from 3 and 4 weeks were pooled and correlation and regression coefficients calculated for the combined set without regard to age with no significant results for either. Since differences in weight within weeks could only be caused by differences in growth rate while differences in weight of the combined set can be caused by both rate and age differences it is indicated that the decline in variation is much more a function of growth than of attained weight. (Biological Abstracts)

NUTRITION

ADKINS, J. S., E. C. MILLER, H. R. BIRD, C. A. ELVEHJEM, and **M. L. SUNDE.** (U. Wisconsin, Madison.)

AN ESTIMATE OF THE THREONINE REQUIREMENT OF THE LAYING HEN. Poultry Sci. 37(6): 1362-1367. 1958.—Single Comb White Leghorn pullets, 2 per group, were fed ad libitum a 12.5% protein ration in 3 experiments. Rations containing dextrin and 7 or 8% crude casein, supplied 0.27 and 0.31% L threonine (microbiological analysis), and were supplemented with vitamins, minerals, antiacid, DL threonine (allo free) and the other essential amino acids in crystalline form. Hens fed 0.27, 0.32 or 0.37, and 0.42 or a higher percent of L threonine lost on the average 412, 160, and 69 g respectively. Egg production of hens fed levels of L threonine below 0.42% averaged about 30% production as compared to 50% production for those fed higher levels. Best feed utilization was obtained when diets contained 0.42% L threonine. When egg production and body weight maintenance are considered, it appears that the L threonine requirement of the laying hen approximates 0.42% of the diet. (Biological Abstracts)

BERG, LAWRENCE R., and **GORDON E. BEARSE.** (Western Washington Expt. Sta., Puyallup.)

PROTEIN AND ENERGY STUDIES WITH DEVELOPING WHITE LEGHORN PULLETS. Poultry Sci. 37(6): 1340-1346. 1958.—Studies have shown that pullets will increase in body weight and attain sexual maturity at the same rate whether given a ration containing 15% protein and 1100 Calories of metabolizable energy per pound or 18% protein and 1300 Calories per pound from 8 to 20 weeks of age. No difference in laying house performance due to difference in develop-

ing diet was noted. Decreasing the protein in all-mash developing rations from 16% to 14% to 12% at 12 and 16 weeks of age, respectively, did not effect body weight gains or age at sexual maturity. Developing pullets given free access to mash and whole grain ate a total ration providing metabolizable Calorie to percent protein ratios of approximately 86/1, 110/1 and 127/1 during the 8-12, 12-16 and 16-20 week growing period. Birds so fed developed as rapidly as those fed an all-mash ration. The pullets used in this test required not more than 15% protein from 8-12 weeks of age, less than 13% from 12-16 weeks and less than 12% from 16 to 20 weeks. (Biological Abstracts)

CARTER, R. D., J. W. WYNE, V. D. CHAMBERLIN, and **M. G. McCARTNEY.** (Ohio Agric. Expt. Sta., Wooster.)

ORAL ADMINISTRATION OF ESTROGENS AND THEIR EFFECT ON GROWTH, FEED CONVERSION AND CARCASS QUALITY OF GROWING TURKEYS. Poultry Sci. 37(6): 1284-1288. 1958.—Two estrogenic compounds, dienestrol diacetate and diethylstilbestrol, and animal fat were included in the rations of Small-type White turkeys during the growing period. Weight gains were significantly improved when levels of 22 or 32 mg of dienestrol diacetate were included per pound of feed and fed for periods of 3 or 6 weeks prior to marketing at 16 weeks of age. However, when 32 mg of dienestrol diacetate was fed from 9 to 12 weeks of age, there was no improvement in weight gains, while diethylstilbestrol fed at the same level improved weight gains. Addition of 5% animal fat, alone or in combination with the estrogens, had no effect on weight gains. The only significant improvement in finish was for the males fed 22 mg of dienestrol diacetate for the period of either 3 or 6 weeks. Feed conversion was not significantly affected by feeding either estrogen, while the addition of 5% animal fat improved feed conversion regardless of the estrogens fed. (Biological Abstracts)

CERCOS, AUGUSTO P. Efecto de algunos colorantes trifenilmetanicos sobre el crecimiento de pollos.

EFFECT OF SOME TRIPHENYLMETHANIC PIGMENTS ON CHICK GROWTH. Rev. Invest. Agric. 12(1): 5-39. Illus. 1958.—The experiments show that the effect of synthetic basic pigments, added as a supplement to the basic ration of chicks, from the 1st day to about the 10th week, varies in accordance with intrinsic and extrinsic factors. It was found that pigments which in certain concentrations cause an inhibition in growth, stimulate it at lower concentrations. In general, the effect of the pigments utilized, such as basic fuchsin, auramine, night blue, rodamine B, etc., was depressive on growth, but it was observed that at the end of the period of experimentation, this latter effect disappeared and chick weight increased rapidly, compared with controls, reaching or even surpassing them (this last difference being statistically insignificant). The return to normality starts around the 8th or 9th week; at the same time it would appear that the amount of pigment in fecal matter increases. Pigments eliminated in fecal matter were identified by paper chromatography and spectrophotometry. Autopsies on animals receiving a supplement of basic fuchsin showed a greater capillary irrigation in all the digestive apparatus, especially the stomach and intestine, but no other alterations were observed. In some of the experiments, the effect of the pigment was visible to the eye. (Biological Abstracts)

CHOY, T. L. 1958.

OBSERVATIONS ON LOCAL (MALAYAN) TROPICAL FOWLS. STUDY II—FOOD INTAKE AND GROWTH RATE DURING REARING. *J. Malay. vet. med. Ass., 2:* 1-8.—Local and selected Canton-type chicks both weighed 6.15 oz. at 4 wks. of age, increasing to 34.8 oz. at 14 wks. Brown Leghorn chicks, imported from the U.K. as day-olds, though heavier, showed the same growth trends as the other 2 groups;

only in the 4th and 5th wks. were they lighter than the Canton-type birds. Food consumption was greatest in the Canton-type. (Animal Breeding Abstracts)

DAY, ELBERT J. (Mississippi State U., State College.)
DEGOSSYPOLIZED COTTONSEED MEAL FOR TURKEY RATIONS. Poultry Sci. 37(6): 1294-1299. 1958.—DG cottonseed meal was inferior to soybean oil meal when used singly as the principal source of protein in poult rations (0-8 weeks); whereas, a 50-50 combination of soy and DG cottonseed meal was equal, if not better, than soy alone. Supplementation of poult rations containing DG cottonseed meal as the principal source of protein with lysine, methionine and tryptophan, singly and in various combinations, resulted in significant growth responses only in those instances where lysine was added. The combination treatments were no better than lysine alone. (Biological Abstracts)

DAY, ELBERT J., and **WOODIE P. WILLIAMS, Jr.** (Mississippi State U., State College.)
A STUDY OF CERTAIN FACTORS THAT INFLUENCE PIGMENTATION IN BROILERS. Poultry Sci. 37(6): 1373-1381. 1958.—Xanthophyll furnished by yellow corn was much more efficiently utilized for pigmentation than that from corn gluten meal or alfalfa meal, and 2 commercial xanthophyll concentrates were only about 50% as effective as alfalfa leaf meal when used to supply comparable dietary levels of xanthophyll. Replacing 5% of the whole corn in broiler rations with stabilized beef tallow significantly increased pigmentation, but increasing the Calorie:protein ratio of the ration during the finishing period from 42 to 50 did not consistently result in a significant increase in pigmentation. Adequate pigmentation was obtained with a dietary xanthophyll level of 6.25 mg per pound when yellow corn was used to contribute a large portion of the xanthophyll; however, when alfalfa meal, corn gluten meal or a combination of these 2 feedstuffs was used as the only source of xanthophyll somewhat higher levels of xanthophyll were needed. (Biological Abstracts)

DRIGGERS, J. CLYDE, and **FRED R. TARVER, Jr.** (Florida Agric. Expt. Sta., Gainesville.)
HIGH PROTEIN PEANUT OIL MEAL WITH FISH MEAL-FISH SOLUBLES BLEND IN BROILER DIETS. Poultry Sci. 37(5): 1107-1111. 1958.—A series of 6 feeding trials using a 55% protein peanut oil meal in a corn-soybean oil meal type ration fortified with DL-methionine, L-lysine, and fish meal with condensed fish solubles is described. The 1st 5 trials were conducted in batteries while the last was conducted on the floor under commercial conditions. When 0.4% L-lysine was added to the diet which was otherwise adequate, particularly in methionine, the peanut oil meal replaced the soybean oil meal with fairly satisfactory results. When fish meal with condensed fish solubles was added to the diet where the high-protein peanut oil meal was needed to replace one-half the soybean oil meal, the results were satisfactory. When the fish meal with condensed fish solubles was present in the diet at a level of 3%, fermentation solubles appeared to be a satisfactory replacement for dried whole whey. (Biological Abstracts)

EDWARDS, H. M., W. S. DUNAHOO, and **H. L. FULLER.** (U. Georgia, Athens.)
THE EFFECT OF CHOLINE AND BETAINE ON THE UTILIZATION OF CAROTENE FROM ALFALFA LEAF MEAL. Poultry Sci. 37(6): 1441-1443. 1958.—The addition of graded levels of alfalfa leaf meal to a vitamin A deficient practical type ration caused an increase in rate of gain, a corresponding increase in efficiency except at the highest level of alfalfa leaf meal, and a decrease in mortality when fed to chickens. At the lower levels of alfalfa leaf meal (0.025%

and 0.1%) or in its absence the addition of choline or betaine was without effect; whereas when either choline or betaine was added to diets containing higher levels of alfalfa leaf meal (0.4% and 1.6%) slight increases in growth rate occurred. This would indicate that neither choline nor betaine increased the utilization of carotene since an increased growth rate should have resulted at the suboptimal levels of alfalfa leaf meal supplementation when choline or betaine were added to the diet if they increased carotene utilization. (Biological Abstracts)

GITLER, C., J. S. FINLAYSON, C. A. BAUMANN, and M. L. SUNDE. (U. Wisconsin, Madison.)
APPARENT BIOLOGICAL VALUE OF PELLETED AND AUTOCLAVED TORULA YEAST MEASURED IN VARIOUS WAYS. Poultry Sci. 37(6): 1314-1320. 1958.—The apparent biological value of pelleted torula yeast for the chick was found to be equivalent to that of soybean oil meal when fed in a practical cereal diet. When the original yeast was used, growth of chicks was not affected by substitution of 60% of soybean oil meal, but a 75 to 100% replacement reduced the weight gain by 15 and 23% respectively. Food consumption decreased due to impaction in the beaks of the chicks fed the high levels of the original intact yeast. The improvement in growth observed after pelleting of torula as compared to the intact yeast appeared due primarily to changes in texture. Experiments with semisynthetic diets suggested that the process of pelleting may have improved the nutritional value of the yeast protein. Autoclaving of the yeast failed to result in a comparable improvement in the apparent biological value of the torula for chicks. Growth on torula, alkali-extracted torula, or brewers' yeast was improved by supplements of methionine and arginine. Other amino acids studied gave no consistent growth response. In rats trained to eat for 2 hours per day, autoclaving improved the growth promoting qualities of both torula and brewers' yeasts when supplemented at high levels to a diet containing 12% of casein. Autoclaving caused no improvement in growth on torula yeast fed as the sole source of protein under ad libitum conditions, or when supplemented to casein at low levels (10% protein or less). Under these latter conditions, torula yeast appeared to be as good a supplement to 12% casein as was brewers' yeast or additional casein, regardless of the feeding method. (Biological Abstracts)

HIRABAYASHI, T., and **K. ICHINOE.** 1958. [Tokyo Agric. Coll.]
STUDIES ON THE GROWTH-PROMOTING EFFECT OF DIETHYSTILBOESTROL ON THE COCKEREL, WITH SPECIAL REFERENCE TO THE EFFECT OF DIVIDED DOSAGE. *Jap J. zootech. Sci., 29:* 174-178. [Japanese with English summary.]—The effects on White Leghorn broilers of several combinations of injection times and of administration of the total dosage at one time were investigated. It is concluded that the best time for injection is between 50 and 55 days of age. Divided dosages were most effective in the case of young cockerels. The more frequent the dosage, the longer did the testes remain in juvenile state. However, as too many injections were time-consuming and caused shock to the birds, not more than 2 injections are recommended. Treatment with diethylstilboestrol resuted in an increase in the breast muscle and a slight decrease in the muscle of the thigh. Fat disposition was greater in injected cockerels. There was little difference between treated and untreated birds in the composition of the meat. (Animal Breeding Abstracts)

HOUPT, T. R. (U. Pennsylvania Sch. Vet. Med., Philadelphia.)
EFFECTS OF FASTING ON BLOOD SUGAR LEVELS IN BABY CHICKS OF VARYING AGES. Poultry Sci. 37(6): 1452-1459. 1958.—Blood sugar responses to fasting in Barred Plymouth Rock-New Hampshire Red cross female chicks, ranging in age from 0 to 14 days, resembled the pattern seen in new-born lambs, calves and foals. Chicks

were resistant to acute hypoglycemia upon fasting as seen in new-born pigs. From the initial concentration of about 200 mg/100 ml, blood sugar fell approximately 30 mg/100 ml in the first 24 hours in all but the newly-hatched chicks, where the decrease was 10 mg/100 ml. This was followed by a gradual rise to near normal levels by the third or fourth day. A further decline to 160 mg/100 ml usually occurred over a day or two, to within 9 hours of time of death. In the final 9 hours a precipitous decline brought the sugar concentration to about 55 mg/100 ml at death. Mean survival time was 6.3 days for newly-hatched chicks, declined to 4.2 days for 2-day-old chicks, and then rose slowly to 6.8 days for 14-day-old chicks. Correlation of body temperature, behavior and postural changes with blood sugar depression was found. A greater percentage loss of body weight during the fatal fasts was found in the older chicks. The involvement of these findings in chick diseases is suggested. (Biological Abstracts)

JACOBS, R. L., J. F. ELAM, JEAN FOWLER, and **J. R. COUCH.** (Texas A. and M. Coll. System, College Station.)
AN UNIDENTIFIED CHICK GROWTH FACTOR FOUND IN LITTER. J. Nutrition 54(3): 417-426. 1954.—Data from two subsequent experiments are reported. For the first experiment 200 chicks were randomized into 5 groups of 40 chicks each, and in the second experiment 800 sexed chicks were randomized into 8 groups of 100 chicks each. An all-vegetable protein diet was supplemented with penicillin, fish solubles, combination of antibiotics (penicillin, aureomycin, terramycin and bacitracin), and autoclaved litter. Samples of litter were collected from poultry houses where the litter had not been changed for at least a three-month period. The litter samples were suspended (0.350 gm of litter per milliliter of water), filtered through cheesecloth and the filtrate autoclaved for 15 minutes at 15 pounds of pressure at 121 to 125° C. Weekly fecal microflora counts were made by standard bacteriological techniques, to determine the number of *Clostridia* and also to determine the number of microorganisms resistant to the combination of antibiotics. Growth was increased by the addition of fish solubles, penicillin, the antibiotic combination, autoclaved litter, and was further increased when the autoclaved litter suspension was fed in combination with fish solubles or with the antibiotic combination. It is concluded that the growth factor in litter is not an antibiotic and differs from the growth factor present in fish solubles. (Biological Abstracts)

MACHLIN, L. J., and **R. S. GORDON.** (Monsanto Chem. Co., St. Louis, Mo.)
RAPID GROWTH OF CHICKENS FED AN IMPROVED SEMI-SYNTHETIC DIET. Poultry Sci. 37(6): 1460-1461. 1958.—Chickens fed a semi-synthetic diet weighed 589-618 g when 4 weeks old. The diet can be used for the assay of various vitamins, minerals or methionine. (Biological Abstracts)

MELJNIKOV, G. V. 1958. Vlijanie gormonov na sootnosenie polov v potomstve kur.
THE EFFECT OF HORMONES ON THE SEX RATIO OF CHICKS. *Pticevodstvo, 8(7):* 40-41.—Work of the Japanese authors T. Sibajama and T. Sirakava is described. Methylandrostenediol or thyroidin was administered to one or to both White Leghorn parents in every possible combination. The greatest deviation from the normal sex ratio (87% ♀ ♀) was obtained by the administration of methylandrostenediol to the cocks and by not treating the hens. The optional dose of methylandrostenediol was found to be 1.5-2 mg. (Animal Breeding Abstracts)

MOTZOK, I., and **H. D. BRANION.** (Ontario Agric. Coll., Guelph, Canada.)
INFLUENCE OF FLUORINE ON PHOSPHATASE ACTIVITIES OF PLASMA AND TISSUES OF CHICKS. Poultry Sci. 37(6): 1469-

1471. 1958.—Quadruplicate groups of 10 chicks each were fed rations supplemented with (1) dicalcium phosphate, (2) dicalcium phosphate plus 0.21% sodium fluoride, providing 0.096% fluorine, and (3) colloidal phosphate (on the basis of 40% available phosphorus and providing 0.096% fluorine) in amounts to supply 0.4% total inorganic phosphorus in the diets. The phosphatase activities of bone and plasma of chicks fed rations with dicalcium phosphate plus sodium fluoride and those with colloidal phosphate were significantly higher ($P<0.01$) than those of chicks fed the ration containing dicalcium phosphate alone. There were no significant differences in the average weights, bone ash, and phosphatase activities of liver, kidney, and intestinal mucosa of the chicks fed the 3 rations. (Biological Abstracts)

MRAZ, FRANK R., R. V. BOUCHER, and M. G. McCARTNEY. (Pennsylvania State U., University Park.)
THE INFLUENCE OF DIETARY ENERGY AND PROTEIN ON GROWTH RESPONSE IN CHICKS. Poultry Sci. 37(6): 1308-1313. 1958.—New Hampshire male chicks (240) were divided into 12 groups of 20 each and placed on experiment at 3 days of age. Three 900 Calorie diets containing 30, 20 and 15% protein were used. From these 3 diets, three 675 Calorie diets containing 20, 15 and 10% protein and three 450 Calorie diets containing 15, 10 and 7.5% protein were derived. A 450 Calorie-20% protein diet was also formulated. The remaining 2 diets were 675 Calorie-15% protein and 450 Calorie-10% protein diets which had the same mineral and vitamin content as the 900 Calorie-20% protein diet from which they were derived. The experimental period was of 10 weeks duration. Energy was expressed in kilocalories (Calories) or productive energy per lb. of diet. The energy:protein (E:P) ratio was determined by dividing the Calorie per lb. by the % protein. The higher the protein content at each energy level, the greater was the growth response. At 4 weeks of age, diets with E:P ratios of 32 or less were significantly superior to those with ratios over 32 as measured by growth. At 10 weeks, diets with E:P ratios of 45 or less were superior to the diets with ratios over 45 as measured by growth. Efficiency of energy utilization improved as the energy decreased in diets derived from the 900 Calorie diets containing 30 and 20% protein. Greatest efficiency of energy utilization was also noted on diets that provided the most protein at the same energy intake. The efficiency of protein utilization, however, was improved at each energy level as the protein content of the diet declined. (Biological Abstracts)

MULLER, ZDENEK. (Lab. Agric. Biochem., Prague.)
EFFECT OF PROCAINE PENICILLIN G ON PERFORMANCE OF HENS. Poultry Sci. 37(6): 1299-1303. 1958.—Experimental feeding of 6000 hens with a diet supplemented with 5 mg procaine penicillin per kg of feeding ration was carried out in 15 poultry stations during 9 months. Average egg production of experimental hens increased by 12%, i.e. by 11 eggs in 9 months. The weight of these eggs increased by 1.4%. The content of beta-carotene and carotenoids was 1, 7, respectively 1, 3, times higher in the eggs of experimental hens as in the controls. Penicillin in the diet influenced also the fertility and hatchability of eggs. The average increase of hatchability for the whole incubation period was 12% and is very significant statistically. The possible factors intervening with these results are discussed. (Biological Abstracts)

OBENKO, K. S. 1958. Vlijaet li perelivanie krovi na rost cypljat.
DOES BLOOD TRANSFER AFFECT THE GROWTH OF CHICKS? *Pticevodstvo, 8(7) :* 38-39.—Each chick in 3 groups of forty 4-mth-old Leghorns was given 5 injections totalling 6.5 ml. blood of hens, turkeys and hens+turkeys resp.; a 4th group of 40 was untreated and served as controls. In the following 70 days the av. daily weight gain of the chicks in the 3 experimental groups was 6.2, 5.3 and 7.9 g. resp. *v.* 5.1 g. for the controls. (Animal Breeding Abstracts)

PARRISH, D. B., and **H. L. MITCHELL.** (Agric. Expt. Sta., Manhattan, Kansas.)

AVAILABILITY TO THE CHICK OF THE CAROTENE OF STABILIZED ALFALFA MEAL. Jour. Agric. and Food Chem. 6(8): 621-622. 1958.—The carotene of alfalfa meal was stabilized against oxidative deterioration during storage by adding 80 pounds of Wesson oil per ton and 0.02% of an antioxidant, and heating the meal at 100°C for 1 hour. Heat treatment did not increase, measurably, the amount of isomerized carotene in the meal. With the chick as test animal, and the Association of Official Agricultural Chemists carotene method for determining feeding levels, the availability of the carotene of the stabilized and stored meals was similar to that of untreated meals whose initial carotene content was maintained by refrigeration. (Biological Abstracts)

RICHARDSON, C. E., A. B. WATTS, and **E. A. EPPS.** (Louisiana State U., Baton Rouge.)

THE EFFECT OF ADDED FIBER WITH AND WITHOUT FAT IN A PRACTICAL BROILER RATION. Poultry Sci. 37(6): 1278-1283. 1958.—Two feeding trials were conducted with broiler-strain, crossbred chicks to study the effect of finely ground rice hulls, ground oats, extracted rice bran, and wheat bran fed at levels calculated to supply 2% and 4% crude fiber with and without 6% and 12% vegetable fat respectively. The addition of fiber depressed gain only when extracted rice bran and wheat bran were fed. Feed conversion was depressed by the addtion of fiber from any source with magnitude of the response varying with each fiber source. Fat overcame or tended to overcome the deleterious effect of the fiber additions. There was a positive fat x fiber interaction within the wheat bran and extracted rice bran rations. The correlation coefficient between calculated productive energy per pound and feed conversion was - 0.89. Finely ground rice hulls acted only as an energy diluent. The productive energy value of extracted rice bran was estimated at 620 calories per pound. (Biological Abstracts)

ROBERSON, R. H., and **PHILIP J. SCHAIBLE.** (Michigan State U., East Lansing.)

THE ZINC REQUIREMENT OF THE CHICK. Poultry Sci. 37(6): 1321-1323. 1958.—Day-old male chicks were reared under conditions to prevent contamination with zinc and fed a corn-soybean oil meal simplified diet. The basal ration contained only 10 ppm of zinc to which 0, 10, 20, 40 and 80 ppm of zinc were added as the sulfate. Twenty ppm of supplemental zinc (total 30 ppm) was minimum for satisfactory growth. Both the sulfate and chloride of Zn were equally satisfactory. Feed efficiency was improved with supplemental Zn. It is concluded that 30 ppm or more of supplemental zinc would insure a ration adequate in Zn for chicks. (Biological Abstracts)

SCOTT, H. M., and **R. M. FORBES.** (U. Illinois, Urbana.)

THE ARGININE REQUIREMENT OF CHICKS IN RELATION TO DIET COMPOSITION. Poultry Sci. 37(6): 1347-1349. 1958.—The addition of cellulose (Solka Floc) to a casein-cerelose purified diet, severely deficient in arginine, at the expense of the carbohydrate, increased feed intake and improved chick growth. When, however, the basal diet was supplemented with increments of L-arginine HCl, the corrective action of cellulose became progressively less and disappeared entirely at the highest level of arginine (2.58%). Growth on the arginine deficient diet was not improved when cellulose was added at the expense of the basal mixture since the consumption of effective nutrients was not increased. Similarly supplemental cellulose failed to alleviate the deficiency of arginine in iso-caloric diets. It was concluded that the improvement in chick growth resulting from substitution of cellulose for cerelose reflects nothing more than the narrowing of the calorie-protein ratio. (Biological Abstracts)

SCOTT, M. L. (Cornell U., Ithaca, N. Y.), **EARL R. HOLM,** and **R. E. REYNOLDS.**

THE CALCIUM, PHOSPHOROUS AND VITAMIN D REQUIREMENTS OF YOUNG PHEASANTS. Poultry Sci. 37(6): 1419-1425. 1958.—The minimum calcium requirement of pheasant chicks from starting to 5 weeks of age was between 0.93 and 1.33%. It appears from the results that the Ca requirement of pheasant chicks is not critical and can be met with safety by any level of Ca between 1.3 and 1.6%. During the growth period between 5 and 14 weeks of age, the Ca calcium requirement for pheasants appeared to be no higher than 0.5%. Under the conditions of these experiments, the minimum total P requirement of pheasants from starting to 5 weeks of age was no more than 0.7%. The P requirement of growing pheasants between 5 and 14 weeks of age was no higher than 0.48%. The minimum vitamin D requirement, under the conditions of these experiments, appears to lie betwen 480 and 680 I.C.U. of vitamin D_3 per pound of ration. (Biological Abstracts)

SCOTT, M. L. (Cornell U., Ithaca, N. Y.), **EARL R. HOLM,** and **R. E. REYNOLDS.**

A STUDY OF THE PHOSPHORUS REQUIREMENTS OF YOUNG BOBWHITE QUAIL. Poultry Sci. 37(6): 1425-1428. 1958.—Studies of the P requirements of Bobwhite quail indicate that, under the conditions of these experiments, the total P requirement during the starting period is approximately 0.6%. The requirement during the growth period between 6 and 12 weeks of age, appears to be no higher than 0.48% of total P. (Biological Abstracts)

SIBBALD, I. R., and **E. OLSEN.** (Ontario Agric. Coll., Guelph, Canada.)

THE CONVERSION OF β-CAROTENE TO VITAMIN A IN THE DUODENUM OF THE CHICK. Poultry Sci. 37(6): 1465-1467. 1958.—β-carotene was injected into ligatured duodenal loops of 6-week-old male chicks. Four hours later the birds were sacrificed and their duodenal loops, which were distended with fluid, were removed. Analyses of the loops indicated that vitamin A was formed from the β-carotene injected but that translocation of the vitamin was inhibited. The inclusion of Na taurocholate in the carotene solution at a level of 2g/100 ml, appeared to have no consistent effect upon the rate of conversion. (Biological Abstracts)

SNETSINGER, D. C., and **H. M. SCOTT.** (Illinois Agric. Expt. Sta., Urbana.)

THE ADEQUACY OF SOYBEAN OIL MEAL AS A SOLE SOURCE OF PROTEIN FOR CHICK GROWTH. Poultry Sci. 37(6): 1400-1403. 1958.—When chicks were fed a highly refined diet consisting of soybean oil meal and cerelose supplemented with vitamins, minerals, corn oil and antibiotic, the protein requirement was well above 20%. It was also shown that an inverse relationship exists between dietary protein level and requirement for sulfur amino acids expressed as a percent of the protein. At sub-optional dietary levels of protein there was a marked response to methionine supplementation, whereas at adequate levels of dietary protein (30%) supplemental methionine was without effect. All essential amino acids were tested in an unsuccessful attempt to determine the 2d limiting amino acid of soybean oil meal. (Biological Abstracts)

SPINKA, J. 1958. [Dep. Biol., Inst. Res. Brewing, Krci.] Sledovani vlivu odstupnovanych davek vitaminu D_2 na kohouty a slepice v dobe rustu, zvlaste s Ohledem na tvorbu kostry, svalstva a pohlavni vyvoj.

THE EFFECT OF VARIOUS DOSES OF VITAMIN D_2 ON COCKERELS AND PULLETS WITH REGARD TO THE SKELETON AND MUSCLE AND ALSO SEXUAL DEVELOPMENT. *Sborn. csl. Akad. Zemed. Ved. Zivoc. Vyr., 3(31):* 439-452. [Russian and English

summaries.]—Vitamin D_2 fed to chicks in the ration increased body weight in ♂ ♂ and ♀ ♀, and increased testes and comb size, induced earlier sexual maturity in ♂ ♂ and increased their sperm production. (Animal Breeding Abstracts)

SQUIBB, ROBERT L., MIGUEL A. GUZMAN, and NEVIN S. SCRIMSHAW. (Inst. Nutricion Centro Amer. and Panama, Guatemala.)

EFFECT OF COMPLETE FEED DEPRIVATION ON FIVE BLOOD SERUM CONSTITUENTS OF NEW HAMPSHIRE COCKERELS. Poultry Sci. 37(6): 1471-1473. 1958.—Complete deprivation of 5-month-old New Hampshire cockerels over a 10-day period caused a 25% mortality, a significant reduction of serum ascorbic acid and total carotenoids and a significant elevation of serum riboflavin. Total serum proteins and vitamin A were depressed although not significantly. The blood serum levels of the starved birds returned to expected levels following a 14-day recovery period. (Biological Abstracts)

TAMIMIE, HAKKI S. (Coll. Agric. Abu-Ghraib, Iraq.)

THE EFFECT OF FEEDING DATES AND DATE PITS TO CHICKS. World's Poultry Sci. Jour. 14(3): 207-210. 1958.—Dates gave a moist appearance to the feed. Levels of 25% or more of dates or pits depressed growth and increased mortality. (Biological Abstracts)

PATHOLOGY

ROBERTSON, G. G., A. P. WILLIAMSON, and R. J. BLATTNER. (U. Tennessee, Memphis.)

A STUDY OF ABNORMALITIES IN EARLY CHICK EMBRYOS INOCULATED WITH NEWCASTLE DISEASE VIRUS. J. Exp. Zool. 129(1): 5-44. 1955.—A study is presented of abnormalities occurring in chick embryos 22-24 hours after inoculation over the blastoderm with Newcastle disease virus at 36, 48, 60, 72 and 84 hours of incubation. Surviving embryos develop to the same stage of gross morphological differentiation as control embryos, but exhibit a high incidence of characteristic defects not seen in control embryos. The defects are observed in the neural tube, lens vesicles and auditory vesicles in embryos inoculated before closure and separation of these organs from the overlying ectoderm, and in visceral arches, limb buds and olfactory primordia. The histopathological changes are the same in all defective organs. These changes consist of cytoplasmic degeneration followed by nuclear disintegration in the ectodermal epithelium of the affected organs, with spread in some cases to underlying mesoderm. It is evident that susceptibility to the virus is greater in the younger than in the older embryos since the highest incidence of lethality occurs in the youngest embryos and the extent of the defect is less in most affected organs in each succeeding age group. The organs found to be susceptible within experimental time limits are those which are directly exposed to the virus and are in early stages of differentiation. Thus, it is evident that exposed organs in which cellular proliferation and differentiation are active are most susceptible to Newcastle disease virus. (Biological Abstracts)

POULTRY PRODUCTS AND MARKETING

BAKER, ROBERT C. (Cornell U., Ithaca, N.Y.), **and R. CURTISS.**

STRAIN DIFFERENCES IN EGG SHELL MOTTLING, INTERNAL QUALITY, SHELL THICKNESS, SPECIFIC GRAVITY, AND THE INTERRELATIONSHIPS BETWEEN THESE FACTORS. Poultry Sci. 37 (5): 1086-1090. 1958.—Specific gravity and shell thickness have a highly significant positive coefficient of correlation. It was discovered that correlations between shell thickness and total egg shell mottling and specific gravity and total egg shell mottling show similar

results. It was shown that internal quality is not significantly correlated to either specific gravity or shell thickness. There is no association between egg shell mottling and internal egg quality. Strains differ significantly in specific gravity, shell thickness, internal quality, and egg shell mottling. (Biological Abstracts)

BOW, YEN FU. (Michigan State U., East Lansing.)
MICROWAVES AS A MEANS OF GRADING EGGS. Food Res. 24(1): 104-111. 1959.—Two different microwave techniques were applied to the study of eggs in the search for a reliable correlation between the albumen quality of an egg and some measurable physical property of the egg. The diffraction method is based on the change in the Fresnel zone of diffraction produced by the presence of an egg. This method is very sensitive to spatial distribution of the dielectric constant inside an egg or to the internal geometry of the egg. The difference in the "geometry" for eggs of different quality appears, however, not to be great enough to allow reliable grading. The microwave interferometer is especially sensitive to changes in the dielectric constant of a substance. The measurements led to the conclusion that in the microwave region a systematic difference in dielectric behavior between eggs of different quality either does not exist or is too small to be measurable. (Biological Abstracts)

DODGE, J. W., W. J. STADELMAN. (Purdue U., Lafayette, Ind.)
POST-MORTEM AGING OF POULTRY MEAT AND ITS EFFECT ON TENDERNESS OF THE BREAST MUSCLES. Food Technol. 13(2): 81-84. 1959.—Experiments were designed to measure the effects of different temperatures, aging media, classes of poultry, and time of aging on post-mortem tenderness of poultry meat. After uniform slaughtering carcasses were aged in air, water, and high concentrations of ozone at given temperatures for designated time periods after death. Carcasses were roasted in aluminum foil. Tenderness measurement was with the Kramer Shear Press. Class of poultry, time of aging, temperature of aging, and media in which the carcasses were aged all appear to be important factors in post-mortem tenderization when the pattern of tenderization and the actual level of tenderness within this pattern are considered. (Biological Abstracts)

HARKIN, ALICE M., CARROLL KITZMILLER, GLADYS L. GILPIN, and **STANLEY J. MARSDEN.** (U. S. Dept. Agric., Beltsville, Md.)
QUALITY OF THE COOKED MEAT OF TURKEYS FED ANIMAL OR VEGETABLE PROTEIN DIETS WITH VITAMIN AND FAT SUPPLEMENTS. Poultry Sci. 37(6): 1328-1339. 1958.—Little difference was found in the quality of the meat from Beltsville Small White fryer-roaster turkeys when roasted at 325°F or when braised at 450°F in a covered roaster, uncovered the last half hour. The appearance of the roasted turkey was better but it took 15 to 25 minutes longer to roast than to braise small turkeys of like weight. Panel members scored thigh meat from turkeys fed the vegetable protein diet with dry vitamin A plus 8% lard higher in flavor and as having less off-flavor than meat from turkeys fed either animal or vegetable protein diets with supplements of 4% lard plus either dry vitamin A or vitamin A and D oil, or the animal protein diet with only vitamin A and D oil added. Thigh meat and skin from all turkeys fed the animal protein diet containing 0.15% vitamin A and D oil had the most off-flavor and the greatest number of comments of fishy off-flavor. The tenderness and juiciness of breast and thigh meat as determined by panel scores and objective methods, flavor and off-flavor of breast meat, and off-flavor of skin were not significantly affected by the diets fed these turkeys. (Biological Abstracts)

HURLEY, WILLIAM C., O. J. KAHLENBERG, E. M. FUNK, LETA G. MAHARG, and NANCY L. WEBB. (U. Missouri, Columbia.)
FACTORS AFFECTING POULTRY FLAVOR. I. INORGANIC

CONSTITUENTS. Poultry Sci. 37(6): 1436-1440. 1958.—Inorganic constituents were analyzed in the leach water from both eviscerated fowl and broilers when chilled in distilled water at 34°F for periods varying from 1 to 24 hours. Further studies were made with 144 eviscerated birds consisting of 72 fowl and 72 broilers divided into 4 equal groups of 18 each and chilled in air, distilled water, and distilled water plus "high and low" levels of inorganic ions for 3, 8 and 18 hours. The meat taste panel found only a small difference in fowl samples, and no difference in broiler meat due to the various chilling methods. Organoleptic evaluation of the broth made from the fowl showed detectable differences between carcasses cooled for various time periods in the different mediums. The broth panel observed differences in broth from broilers cooled in various mediums but not in carcasses cooled for various lengths of time. Absorption and loss of water of both broiler and fowl carcasses were similar for time periods but not when treatments were compared. (Biological Abstracts)

KLOSE, A. A., M. F. POOL, M. B. WIELE, H. L. HANSON, and **HANS LINEWEAVER.** (Western Regional Res. Lab., Albany, Calif.)
POULTRY TENDERNESS. I. INFLUENCE OF PROCESSING ON TENDERNESS OF TURKEYS. Food Technol. 13(1): 20-24. 1959.—Tenderness of turkey fryers and some turkey roasters was studied as a function of conditions of scalding, feather picking, and holding (aging) at various temperatures before, during, and after frozen storage. Tenderness of turkey fryers increased progressively with increase in aging time up to at least 12 hours. Changes were rapid and highly variable within the first 4 hours. Very little, if any, additional tenderization took place from 12 hours to 24 hours post mortem, and even to a total aging time of 4 or 5 days. Turkey roasters appeared to be adequately tenderized after only 4 hours of chilling. For the same size and age of turkey, deep-fry frying resulted in much tougher meat than roasting. Holding inadequately aged, turkey fryers for 9 months at 0°F had no tenderizing effect. Holding fryers in a thawed state after frozen storage had as much tenderizing effect as an equal period of chilling before freezing. Machine picking resulted in cooked meat about twice as tough as for hand-picked controls. Differences in shear values between machine-picked and hand-picked birds were unaltered by extended chilling periods. (Biological Abstracts)

LEONG, K. C. (U. Wisconsin, Madison.) **M. L. SUNDE, H. R. BIRD,** and **K. G. WECKEL.**
TASTE PANEL EVALUATION OF THE EFFECT OF ADDED FAT ON THE FLAVOR OF CHICKEN MEAT. Poultry Sci. 37(5): 1170- 1172. 1958.—Two taste panel evaluations indicated no significant difference between light and dark meats of birds fed a diet with 26% added fat and meats of those fed without added fat. Average scores obtained for all samples tested were positive, indicating all were acceptable in flavor. In the case of the skins, there was a preference for the flavor of the skins of the chickens fed the high fat diet. (Biological Abstracts)

MELLOR, D. B., P. A. STRINGER, and **G. J. MOUNTNEY.** (Texas Agric. Expt. Sta., College Station.)
THE INFLUENCE OF GLYCOGEN ON THE TENDERNESS OF BROILER MEAT. Poultry Sci. 37(5): 1028-1034. 1958.—Glycogen, pH and tenderness determinations were made on White Rock broilers either fasted, allowed access to water only, to broiler mash and water, or to a sugar-broiler mash mixture and water for a 16-hour-period prior to slaughter. The fasted group of broilers had a higher muscle glycogen level than did the group which was fed the sugar-broiler mash mixture. The other 2 groups did not differ significantly from either the fasted birds or the sugar-fed birds. Muscle shear values from the Pectoralis minor muscles of the 18 birds of highest glycogen concentrations were lower than shear values of corresponding muscles from the birds of

lowest glycogen concentrations. The pH of muscle tissue for the group of carcasses with highest glycogen concentration decreased from an initial value of 6.4 to a pH of 5.9 after being stored, frozen. The pH of the group of carcasses with the lowest glycogen level did not change. (Biological Abstracts)

MEYER, R. C., A. R. WINTER, and H. H. WEISER. (Ohio Agric. Expt. Sta., Columbus.)

EDIBLE PROTECTIVE COATINGS FOR EXTENDING THE SHELF LIFE OF POULTRY. Food Technol. 13(2): 146-148. 1959.—Coating cut-up poultry with 3 or 4% water solution of agar and carrageenin gel at 150°F in which antibiotics were incorporated at 15 or 20 ppm, extended shelf life beyond that of untreated controls or soaking in antibiotic solution. Chlortetracycline and oxytetracycline were of equal value. The efficiency of the former was improved when used in combination with mycostatin. (Biological Abstracts)

POOL, M. F., D. deFREMERY, A. A. CAMPBELL, and A. A. KLOSE. (Western Regional Res. Lab., Albany, Calif.)

POULTRY TENDERNESS. II. INFLUENCE OF PROCESSING ON TENDERNESS OF CHICKENS. Food Technol. 13(1): 25-29. 1959.—Tenderness of chicken fryers was studied as related to conditions of scalding, feather picking, chilling or aging, and frozen storage. Significant but small increases in toughness were produced by increasing either the scalding temperature or the scalding time within the commercial ranges. The ultimate toughness after aging increased with extent of beating action incurred by the carcass during feather removal. Determinations of toughness as a function of temperature and time of aging showed that most tenderization takes place within 4 hours at chill temperatures. No appreciable tenderization occurred at 0°F over a 4-month period, but significant tenderization took place in frozen carcasses held at 25° to 27°F for several days. Tenderization arrested by freezing proceeded at about a normal rate on thawing. Cutting up the carcass in the early post-mortem period had a small toughening effect. (Biological Abstracts)

ROWAN, JAMES D., KARL H. NORRIS, and CHARLES K. POWELL. (U.S. Dept. Agric., Beltsville, Maryland.)

A METHOD FOR MEASURING THE RHEOLOGICAL PROPERTIES OF EGGS. Food Res. 23(6): 670-676. 1958.—A torsion pendulum device equipped with a photo-electric unit is used for measuring the rheological properties of eggs for an oscillation range from 0.2 to 30 cps. At a frequency of 2.6 cps, this measuring technique gave a correlation coefficient (r) of 0.74 between damping factor and Haugh Units value on 318 eggs varying in albumen quality from grade AA to C. This technique can be used to separate low quality eggs from those of high quality but is not sufficiently accurate for grading eggs. Characteristics of eggs from the same hen were inconsistent when measured by this technique. The torsion pendulum technique is applicable to the measurement of viscosity of water-glycerol solutions over a range from 1.0 to 50 centipoise. (Biological Abstracts)

WELLS, F. E., J. Y. SPENCER, and W. J. STADELMAN. (Purdue U., Lafayette, Ind.)

EFFECT OF PACKAGING MATERIALS AND TECHNIQUES ON SHELF LIFE OF FRESH POULTRY MEAT. Food Technol. 12(8): 425-427. 1958.—Comparison of vinylidene chloride copolymer films (evacuated and unevacuated) and cellophane for ability to extend shelf life of poultry meat indicates that the films do not exert a direct bacteriostatic effect but that reduced oxygen tension due to evacuation of the impermeable film is effective in increasing storage time. The reduced oxygen tension also influences the degree of response to treatment with antibiotics; effect of antibiotic being somewhat lessened by

reduced oxygen in the package. Trays and absorbent pads did not contribute greatly to the fungal flora which developed on the antibiotic treated chickens. (Biological Abstracts)

WESLEY, R. L., J. J. KORSLUND, Jr., and W. J. STADLEMAN, (Purdue U. Lafayette, Indiana.)
THE EFFECT OF HORMONIZATION ON JUICINESS AND TENDERNESS OF CHICKEN MEAT. Poultry Sci. 37(6): 1443-1446. 1958.—Chickens (148) were tested for tenderness and juiciness. Of these birds 74 were hormonized and 74 were nonhormonized. Results indicate that hormonization had no significant effect on juiciness, of 6- or 10-week-old chickens: hormonization significantly increased juiciness of 14-week-old chickens: female chickens were more juicy than males: hormonization significantly increased tenderness of all the birds tested with the exception of the 6-week-old birds. (Biological Abstracts)

WOODMANSEE, C. W., and O. J. ABBOTT. (Delaware Agric. Expt. Sta., Newark.)
COATING SUB-SCALDED BROILER PARTS IN ORDER TO AFFORD PROTECTION AGAINST DEHYDRATION AND SKIN DARKENING IN FRESH STORAGE. Poultry Sci. 37(6): 1367-1373. Illus. 1958.—Legs from broilers scalded at 128, 132, 136, or 140° F for 30 seconds were treated with "Myvacet" (an acetylated monoglyceride from lard) to provide a skin-tight, non-greasy, potentially edible coating. The immersion of legs from sub-scalded broilers (140°F) in a 2+1 mixture of Myvacet types 5-00 and 9-40, respectively, at 200°F for 1 second formed a coating which reduced dehydration at 40°F for 10 days to 6.3% as compared to 30.2% for uncoated legs under the same conditions. The coating amounted to about 3% of the initial weight. Following 10 days of storage at 40°F, the coating was removed with ease by washing under a hot water tap (120°F or hotter), and the broiler legs retained a natural appearance with no distinguishable off-odor. The Myvacet coating was very effective in preventing dehydration and skin darkening at all scalding temperatures investigated, including 128, 132, 136, and 140°F. The most marked protection followed scalds of 136°F or higher where the epidermal layer of the skin was removed during the process of feather removal. (Biological Abstracts)

MANAGEMENT

BARNETT, B. D., E. C. NABER, J. B. COOPER, and C. L. MORGAN. (South Carolina Agric. Sta., Clemson.)
INFLUENCE OF RANGE AND CONFINEMENT REARING OF TURKEYS ON GROWTH, FEED CONSUMPTION AND BODY CONFORMATION. Poultry Sci. 37(6): 1304-1308. 1958.—For 3 consecutive years confinement-reared Broad Breasted Bronze and Small Type White turkeys were compared to similar birds reared on Bermuda grass, Korean lespedeza, or sericea lespedeza range from 8 to 24 weeks of age. The percentage of broad breasts was greatly increased by range rearing especially among males. No differences were observed in growth rate, feed efficiency or mortality between range-reared and confined birds. (Biological Abstracts)

DAVIDSON, J.
CEREAL PRICES AND THE PRODUCTION OF TABLE BIRDS. Scottish Agric. 38(2): 61-64. 1958.—An analysis is made of the costs of various types of ration, the seasonal variation of these costs, the productivity value of the types of rations and the final economic cost of table bird production following one of three types of ration. (Biological Abstracts)

HART, SAMUEL A., THAYER CLEAVER, W. O. WILSON, and **A. E. WOODWARD,** (California Agric. Expt. Sta., Davis.)
HOUSING AND OPERATIONAL STUDIES ON CALIFORNIA EGG FARMS. Poultry Sci. 37(6): 1386-1395. Illus. 1958.—The 3 common poultry housing designs—litter, individual cage, and wire pen, were compared for their labor requirements. The influence of house design was found to be less important than the management technique for the poultryman. It was also found that the 3 chores - feeding, egg gathering, and egg cleaning, required two-thirds of the total daily chore time. Mechanization of feeding was advantageous, but little benefit resulted from mechanization of egg cleaning. Suggestions are given on how to make one's labor more effective. (Biological Abstracts)

JULL, MORLEY A.
RELATIVELY HIGH EFFICIENCY OF EGG AND CHICKEN-MEAT PRODUCTION. World's Poultry Sci. Jour. 14(3): 203-206. 1958. (Biological Abstracts)

MAULDON, R. G. (Inst. Agric., U. Western Australia, Perth.)
A LEAST COST FEED FOR LAYING HENS USING LINEAR PLANNING. Jour. Australian Inst. Agric. Sci. 24(4) : 353-357. Illus. 1958.—An application of linear programming, a method using mathematical equivalents for all variables, is made to the selection of an efficient least cost ration for laying hens. (Biological Abstracts)

MORRIS, T. R., and **S. FOX.** 1958. [Dep. Agric., Univ. Reading.]
ARTIFICIAL LIGHT AND SEXUAL MATURITY IN THE FOWL. *Nature* [*Lond.*], *182:* 1522-1523.—Four groups, each of 150 Rhode Island Red×Light Sussex pullets hatched on 4th Dec. 1957, were reared under identical conditions except for light treatment. The 2 control groups received natural daylight only (lat., 51° 27′N.); the other groups were illuminated continuously for the 1st wk. of life; thereafter day length was reduced by 35 mins. each week to reach a level of 14 hrs. 5 mins. at 17 wks. of age (3rd April). All 4 groups were then transferred to laying cages and subjected only to natural lighting until after the summer solstice, by which time all the birds were in lay. Decreasing day length delayed sexual maturity by 24 days in the experimental groups, even although they received more light than did the naturally lit controls.

To measure the benefits that accrue from using lights to delay maturity in pullets hatched in Dec. a study is being made of egg production, egg weight, body weight and mortality to 450 days of age in the treated groups. From the results available up to 36 wks. of age, it is apparent that light treatment has brought about an improvement in rate of lay sufficient to offset the 3 wks. delay in maturity, and has also resulted in a substantial increase in egg size. (Animal Breeding Abstracts)

NORDSKOG, A. W., and **J. F. HILL.** (Iowa State Coll., Ames.)
CORRELATION BETWEEN EGG PRODUCTION AND ADULT VIABILITY IN HYBRID FLOCKS. Poultry Sci. 37(6): 1265-1273. 1958.—From a statistical analysis of field test comparisons of commercial chicken hybrid varieties, estimates of phenotypic and genetic population parameters for hen-day rate of egg production, hen-housed rate of egg production, and laying house viability were obtained. The data involved 31,019 pullets tested over a 4-year period. The phenotypic and genetic correlations between hen-day production and viability averaged .14 and .42, respectively. Utilizing the information supplied from the data a discriminant function selection index for egg production and viability was constructed. This index was shown to be 18% more efficient than the commonly used hen-housed production index. (Biological Abstracts)

ROMIJN, C., and **A. H. J. VISSCHEDIJK.** 1958. [Lab. Vet. Physiol., State Univ., Utrecht.] De ventilatie bij het kunstmatig broeden.

VENTILATION DURING ARTIFICIAL INCUBATION. *Tijdschr. Diergeneesk., 83:* 1149-1158. [English, French and German summaries.] —A method for estimating the ventilation of incubators and incubator rooms is described, and instructions are given for regulating the carbon dioxide content of the air of the incubator. On the 10th day of incubation each egg produces 70 cm.^{3} CO_2 in 24 hrs.; on the 20th day CO_2 production has risen to 480 cm.^{3} The heat given off by the incubating eggs causes ventilation problems in hot weather. It is possible to estimate heat production from the amount of CO_2 in the air. (Animal Breeding Abstracts)

VAN ALBADA, M. 1958. Invloed van verlichting en stalklimaat op de eiproduktie van kippen.

THE EFFECT OF LIGHTING AND OF THE CLIMATE OF THE HEN-HOUSE ON THE EGG PRODUCTION OF DOMESTIC FOWLS. *Tijdschr. Diergeneesk., 83:* 1034-1055. [B.] [English, French and German summaries.] Discussion: 1275-1276.—The literature on the effect of various climatic factors on egg production and temperature regulation, and the effect of temperature on egg yield, egg weight, shell quality and internal quality is reviewed. It is concluded that an air temperature a few degrees above freezing point (5°-10° C.) is high enough to allow optimum production in laying hens without the provision of extra heat, provided that the birds are moving about. For hens in batteries the optimum temperature is estimated to be 47° F. (8°-9° C.). The domestic fowl shows great heat tolerance if the environmental temperature is constant, but reacts unfavourably to sharp changes of temperature. High temperatures adversely affect both egg weight and shell quality. The injurious effect of high temperatures on egg yield becomes noticeable only at about 25° C. (Animal Breeding Abstracts)

WOODS, ROBERT E., (Dahlonega Hatchery. Dahlonega, Ga.) and **CHARLES K. LAURENT.**

A NOTE ON NEST PREFERENCE. Poultry Sci. 37(6): 1461-1462. 1958.—Pullets (250) were observed once weekly over a 23-week period to determine nest preference. Four 10 unit double-deck nests were hung in a continuous row along one side of the pen. There was no pattern as far as number of eggs laid in individual nests. The number of eggs laid in the top layer of nests was significantly higher than in the lower layer. Also, more eggs were laid in nests located in the darker area than those in the lighter area. (Biological Abstracts)

WRIGHT, L. M., and **N. H. EPPS.** (Ontario Agricultural Coll., Guelph, Ontario, Canada.)

HATCHERY SANITATION. Canadian Jour. Comp. Med. and Vet. Sci. 22(11): 396-399. 1958.—Fluff samples taken from incubators before and after fumigation are examined microbiologically in order to assess and report on the effectiveness of fumigation. (Biological Abstracts)

GENERAL

BOBBY, F. C. 1958. [Dep. Agric., Wellington.]

HOW POULTRY FARMING HAS DEVELOPED. *N.Z.J. Agric., 97*: 121, 123-124.—A brief survey of the poultry industry in New Zealand is given. The industry is primarily concerned with producing eggs for home consumption. At the last census (April 1956) there were 4,160,424 domestic fowls, 210,718 ducks, 60,938 geese and 53,491 turkeys. Although no breed statistics are available for New Zealand, it can be deduced from blood testing records by the Department of Agriculture, and the annual list of accredited breeders in the New

Zealand Poultry Flock Improvement Plan, that White Leghorns comprise over 50% of the fowl population and Australorps between 30 and 40%. Crossbreds also play a large part in egg production, the most popular crosses being White Leghorn × Australorp, Rhode Island Red × W. L. and their reciprocal crosses. (Animal Breeding Abstracts)

HIRST, H., and **AGROTIS, A.** 1958.

THE DEVELOPMENT OF THE POULTRY INDUSTRY IN CYPRUS. *Trop. Agriculture [Trin.], 35:* 251-256.—This is a general account of the recent rapid expansion of the industry, especially in broiler production. The largest unit is producing 350,000 broilers a year and can accommodate 80,000-90,000 chicks. Birds are slaughtered at 10-12 wks. when they weigh, alive, 2½-3 lb. Much of the broiler stock has been imported from Israel but it is hoped that Cyprus will eventually become self-sufficient in chicks.

Two experimental units have been established at hill stations where trials are being carried out to extend the hatching season. (Animal Breeding Abstracts)

TRETJJAKOV, N. 1958. [All-Un. Poult. Breed. Res. Inst.] Pticevodstvo v Cehoslovakii.

POULTRY BREEDING IN CZECHOSLOVAKIA. *Nauka Pered. Opyt. sel. Hoz.*, 1958 *(6):* 78.—In 1890 White Wyandottes, Rhode Island Reds and Minorcas were imported into Czechoslovakia to improve egg production and carcass quality. In 1905 Leghorns were imported and supplanted all the other breeds. At 1st Jan. 1957 fowls totalled 21 million hens and 1-3 million cocks, geese 1 million, ducks 375,000 and turkeys 125,000. In commercial flocks av. egg yield was 92 *v.* 174 in breeding flocks. Organisation of breeding work is described. (Animal Breeding Abstracts)

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The Ministry of Agriculture and Fisheries, 3 Whitehall Place, London S.W.1

GERMANY

Landwirtschaftskammer Westfalen und Lippe Abtl. Tierzucht, Postfach 842, Münster (Westfalen)

Ministerium für Ernährung, Landwirtschaft und Forsten, Rossstrasse 135, Düsseldorf

INDIA

The Government of India, (The High Commissioner for India, External Dept., India House, Aldwych, London W C 2, England)

MEXICO

Secretaria de Agricultura y Ganaderia, Tacuba 7, Mexico, D.F.

NORTHERN IRELAND

Ministry of Agriculture, The Secretary, Stormont, Belfast

SCOTLAND

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UNION OF SOUTH AFRICA

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DENMARK

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M. Khalifa, Poultry Department, College of Agriculture, Alexandria
A. Z. Khalil, Poultry Department, College of Agriculture, Alexandria
Y. Madkour, Animal Production Dept., Ministry of Agriculture, Cairo
A. Mostafa, Inshas Poultry Station, Inshas Shakia
A. M. Obeidah, Animal Production Dept., College of Agriculture, Cairo University, Cairo
A. A. Saleh, Dean, College of Agriculture, Einshams U., Cairo
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C. L. Coles, I.C.I. Game Research Station, Burgate Manor, Fordingbridge, Hampshire
A. J. Davey, "Longacre", Risborough Road, Stoke Mandeville, Aylesbury, Bucks.
Mary K. Davies, National Institute for Research in Dairying, Shinfield, nr. Reading, Berks.
Lionel Davis, The Little House, Furze Common, nr. Storrington, Sussex
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H. E. Griffiths, Marton, Pattingham Road, Compton, Wolverhampton
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Alexander King, Waverly House, New North Road, Huddersfield, Yorks.
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Miss Mary M. E. Stirling, 21 Regina Road, Chelmsford, Essex

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C. S. Walden, Holden, Chipperfield Road, King's Langley, Herts.
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Prudencio Falcon, 1038 Constancio St., Sampaloc, Manila

PORTUGAL

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Max Schaffner, Ziegelfeldstrasse 2, Olten

U. S. A.

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Charles K. Laurent, Marbut Milling Co. Ltd., Augusta, Ga.
Robert P. Mitchell, Poultry Department, University of Tennessee, Knoxville, Tenn.
David B. Shoaf, Poultry Department, University of Tennessee, Knoxville, Tenn.
James F. Stephens, Poultry Department, University of Tennessee, Knoxville, Tenn.

CHANGES OF ADDRESS

AUSTRALIA

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P. R. Pike, 7 Victoria Road, Castle Hill, N.S.W.

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John Getty, Wingate House, 93/107 Shaftesbury Avenue, London W. 1
R. H. Macnab, 15 Digswell Road, Welwyn Garden City, Herts.
R. H. Mendenham, Pilgrims, Compton Down, Winchester, Hampshire
John I. Portsmouth, 58 Freehold Road, Ipswich, Suffolk
Harry Strike, 311 New Hall Lane, Preston, Lancs.

GERMANY

Frl. Dr. Wegner, Endenicher Allee 15, Bonn

NETHERLANDS

J. C. Leinweber, 2 Prins Mauritslaan, Vught
A. L. W. Visser, 143 Ruys de Beerenbrouckstraat, Apeldoorn

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R. B. Cumming, P.O. Onderspoort, via Pretoria, Transvaal
J. Zwarenstein, Private Bag 1005, Pietermaritzburg, Natal

SWITZERLAND

W. Thomann, Schweizerischer Geflugelzuchtverband, Zollikofen (Bern)

U. S. A.

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A. W. Brant, Food Science and Technology Dept., University of California, Davis, Cal.
E. G. Buss, 105 Weaver Hall, Penn. State University, University Park, Pa.
C. E. Cooke, 1516 Chelmsford, St. Paul, Minn.
J. H. Clements, 4352 Mayette Ave., Santa Rosa, Calif.
W. P. Elmslie, 30 West Lincoln Hill, Quincy, Ill.
D. W. Francis, Dept. Poultry Husbandry, New Mexico State University, University Park, N. M.
H. H. Kauffman, Poultry Extension Dept., University Park, Pa.
I. Michael Lerner, Dept. of Genetics, University of California, Berkeley 4, Calif.
G. A. Martin, 3405 Ruffin St., Raleigh, N. C.
J. W. Megown, Morton Salt Company, 110 N. Wacker Drive, Chicago 6, Ill.
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F. E. Mussehl, 1347 North 38th St., Lincoln 3, Neb.
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